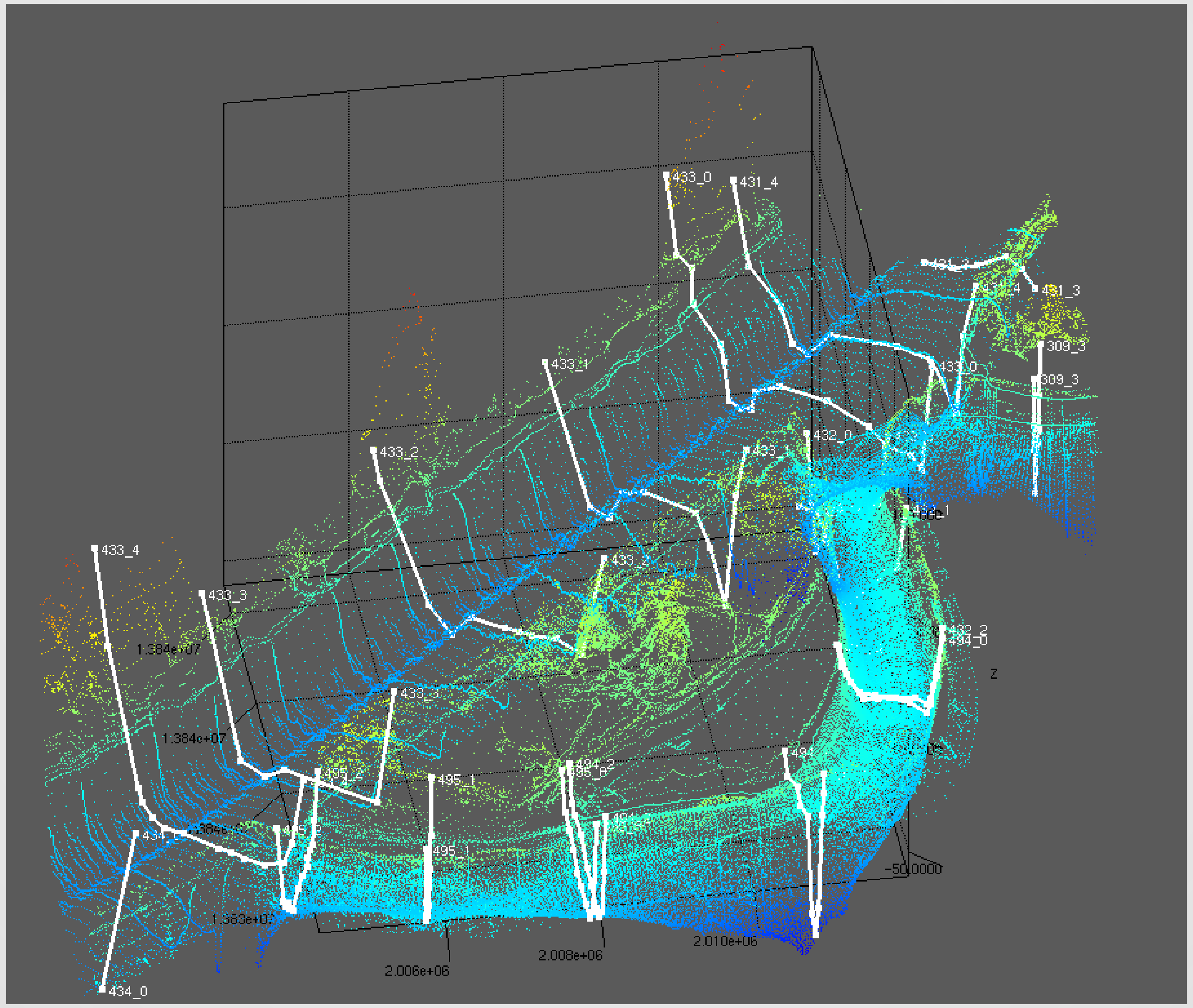
CALIFORNIA DEPARTMENT OF WATER RESOURCES

Update: DSM2 Cross-Section Development Program (CSDP)

CWEMF Annual Meeting, May 12, 2025



Brad Tom, DWR Modeling Support Office

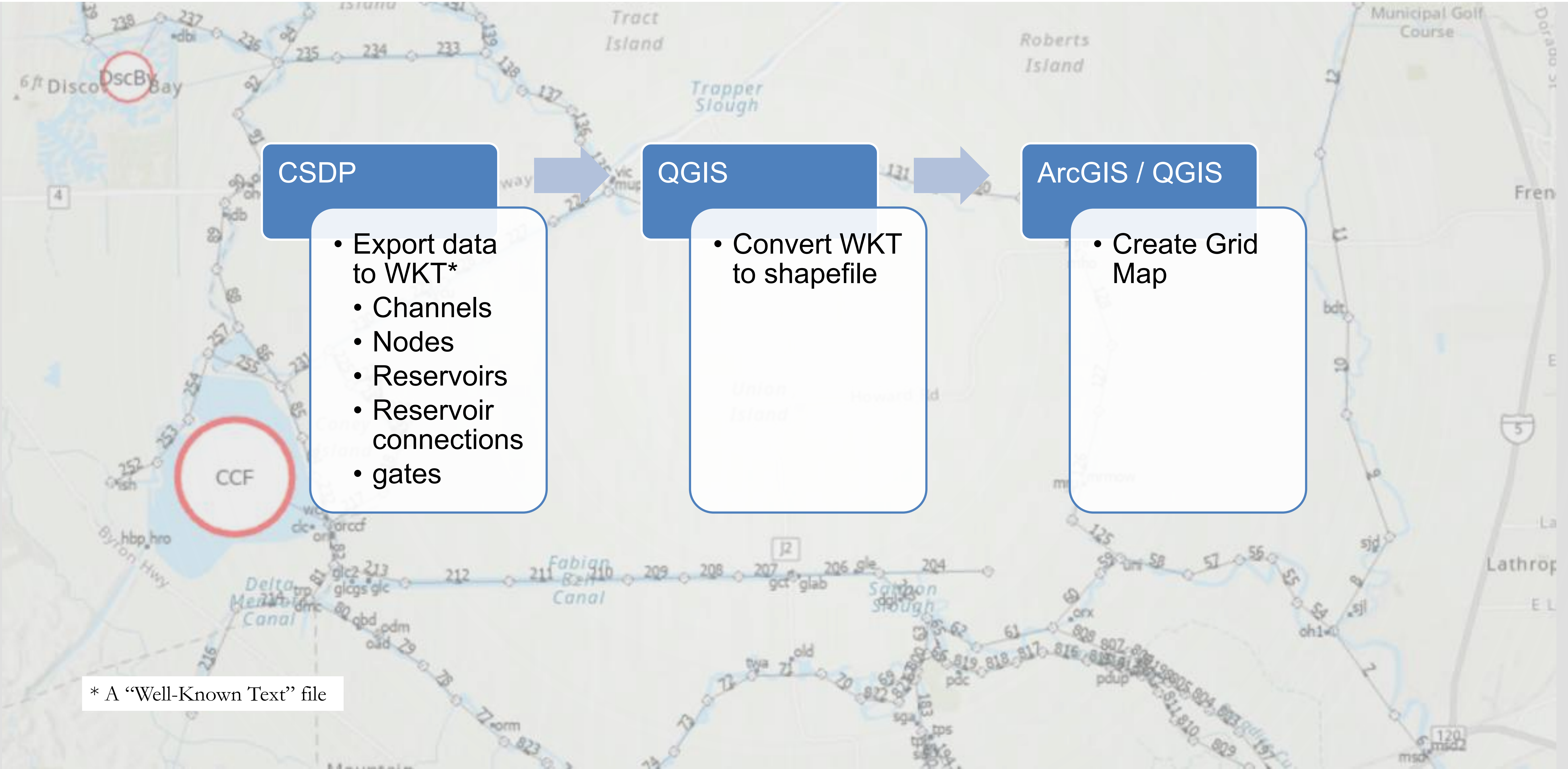
Overview

1. Create shapefiles from CSDP data, for GIS model grid maps
2. Automatic cross-section creation
3. Creation of output locations for DSM2
4. Tools to help improve DSM2 Hydro convergence

Creating GIS shapefiles from CSDP data

* A "Well-Known Text" file

Creating GIS shapefiles from CSDP data



CSDP

- Export data to WKT*
  - Channels
  - Nodes
  - Reservoirs
  - Reservoir connections
  - gates

QGIS

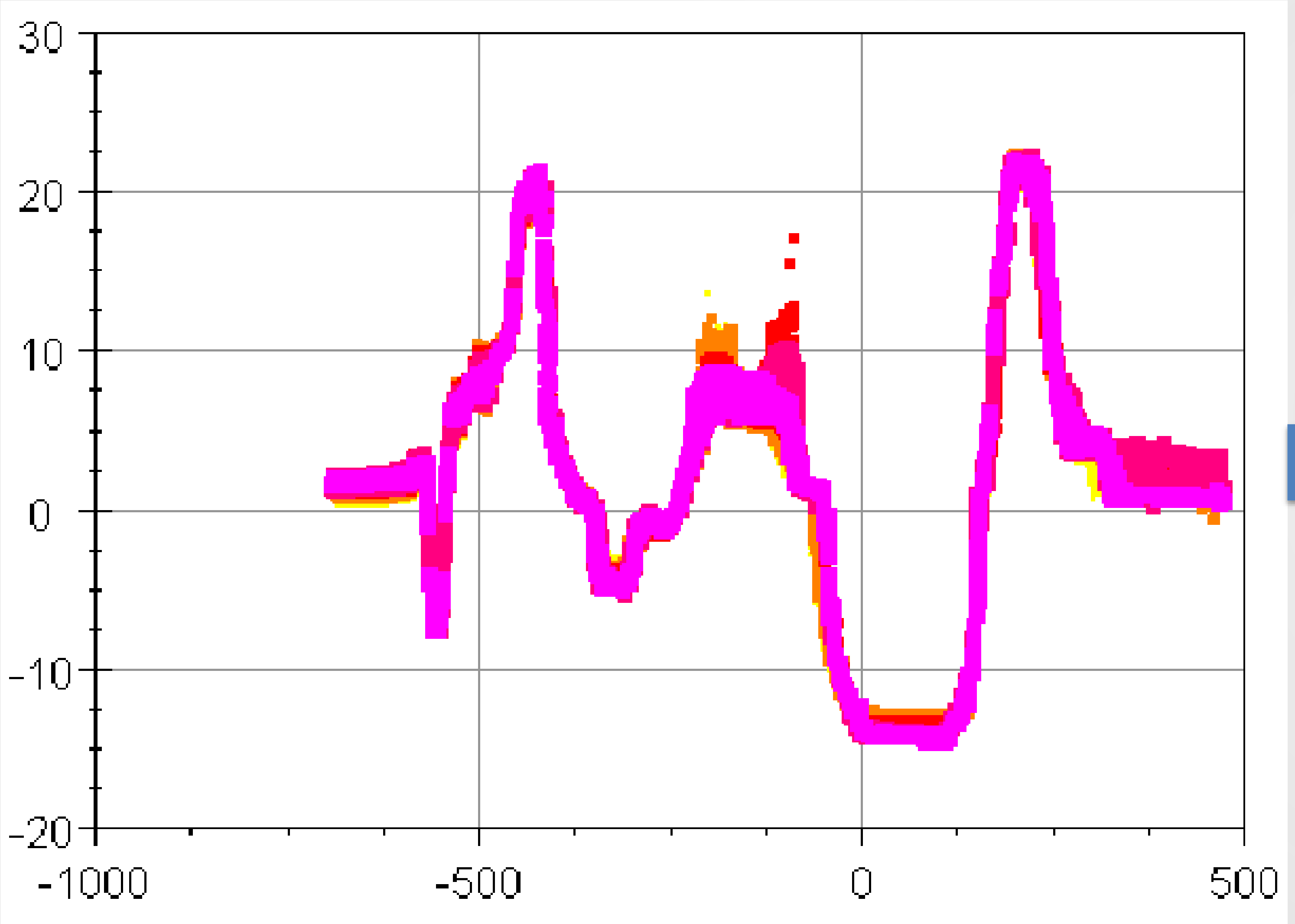
- Convert WKT to shapefile

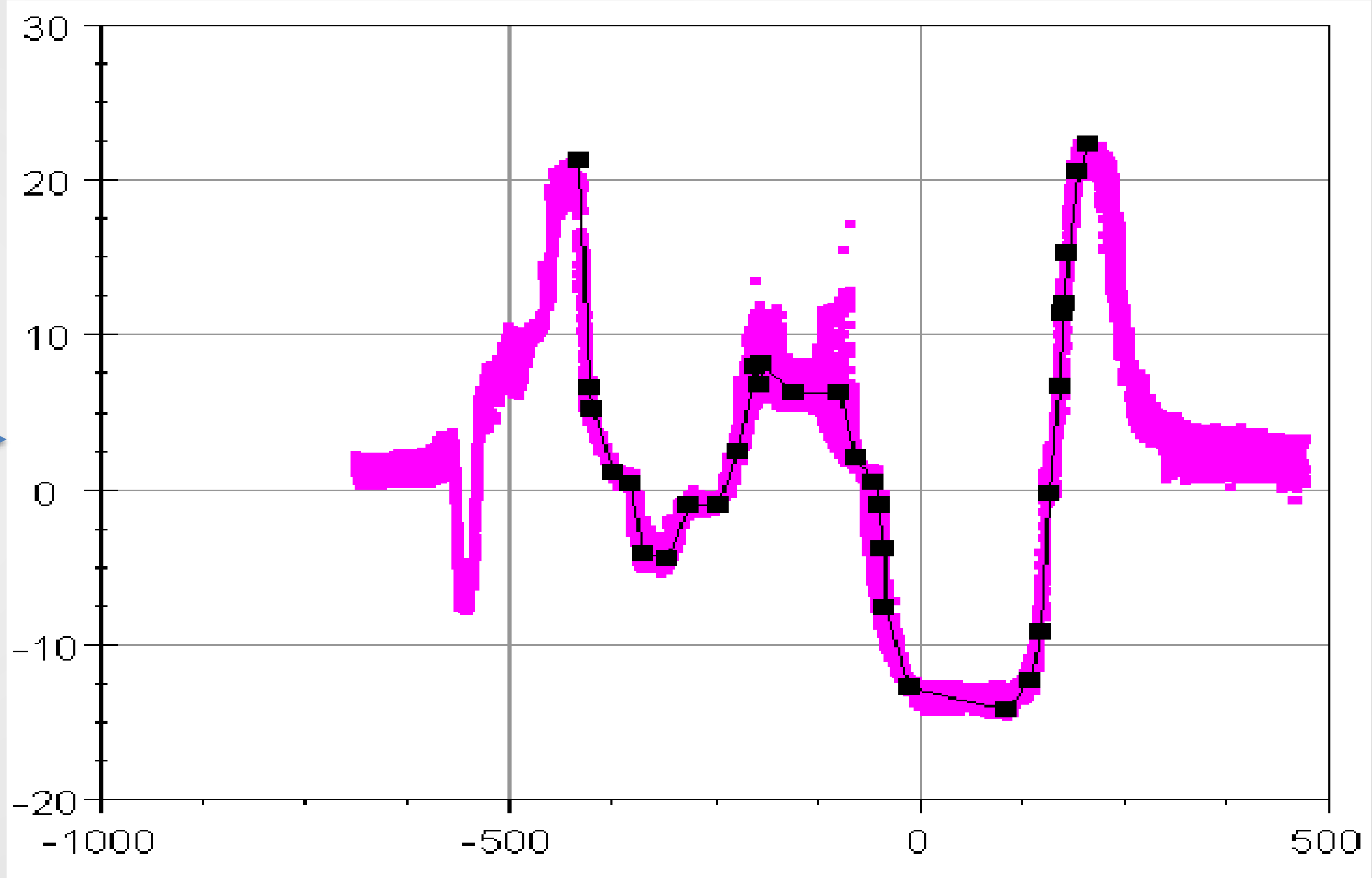
ArcGIS / QGIS

- Create Grid Map

* A "Well-Known Text" file

Automatic Cross-Section generation





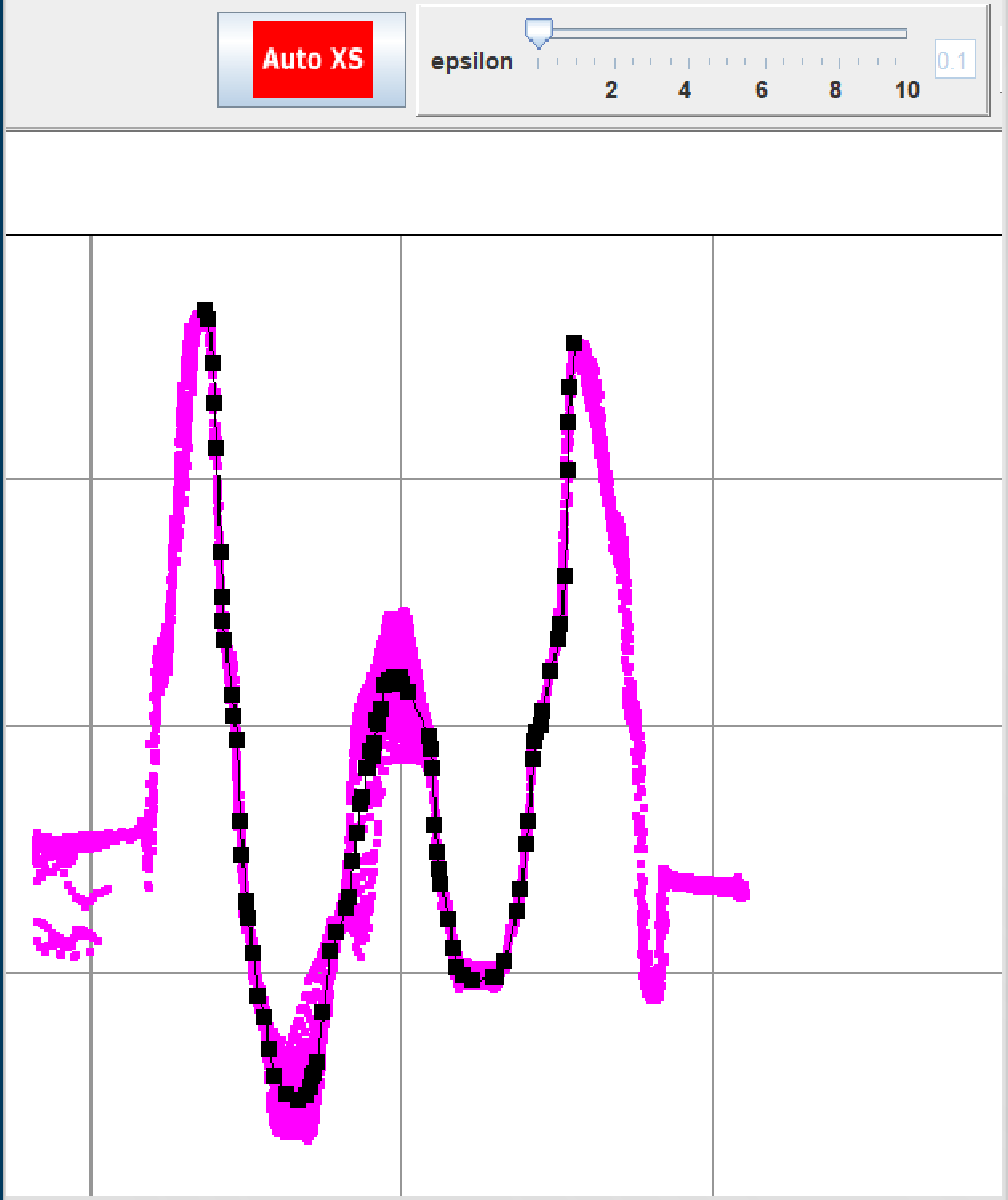
Automatic Cross-Section generation

- Can be used with, or instead of manual process
- Works better if less scatter in data
- Ramer-Douglas-Peucker (RDP) algorithm
  - Used for line simplification
  - Uses epsilon ε (Tolerance):
    - determines the maximum distance a point can deviate from the line segment connecting the end points of a curve segment before being considered for removal.

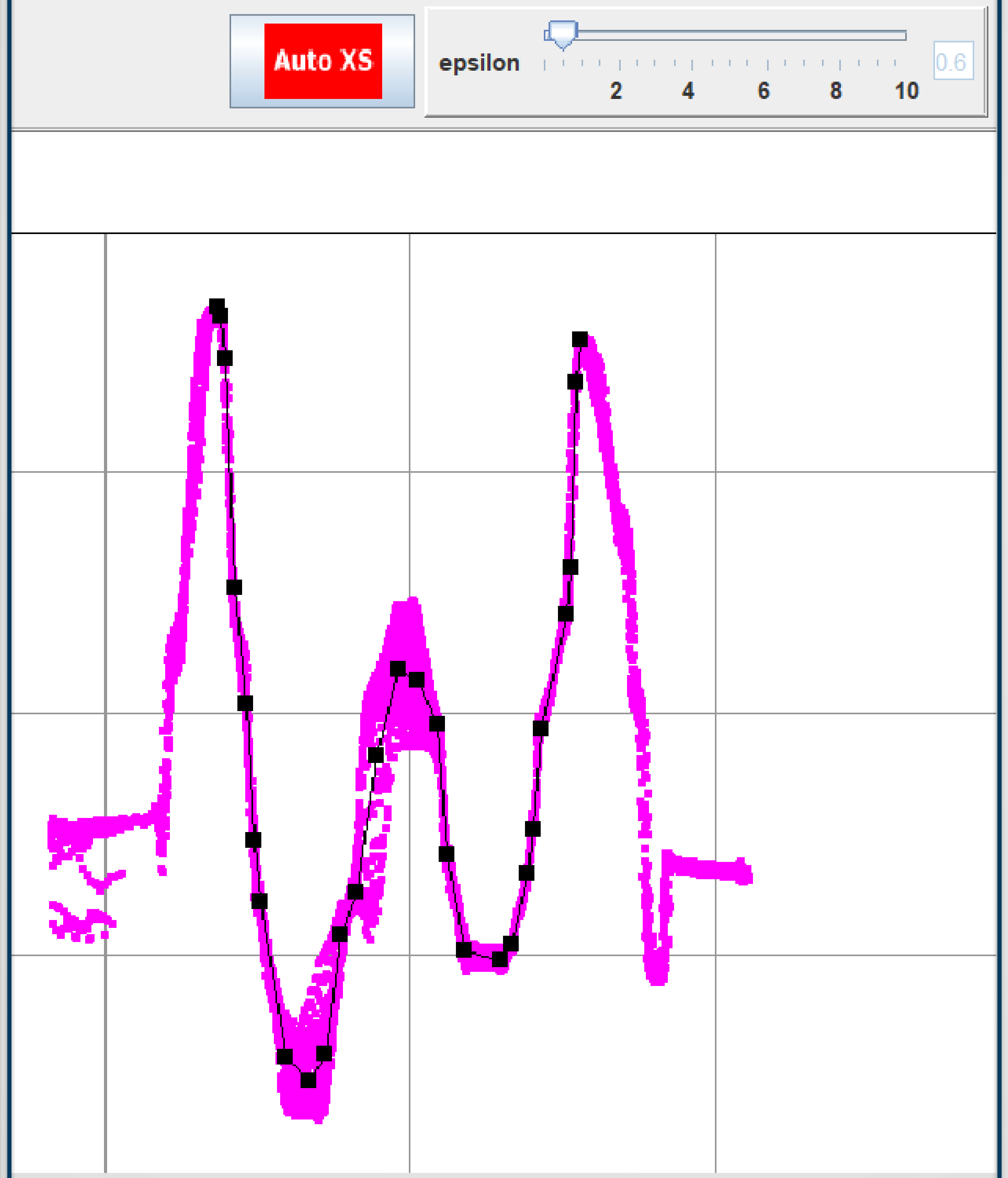
Automatic Cross-Section generation

Adjusting epsilon (ε) for best fit

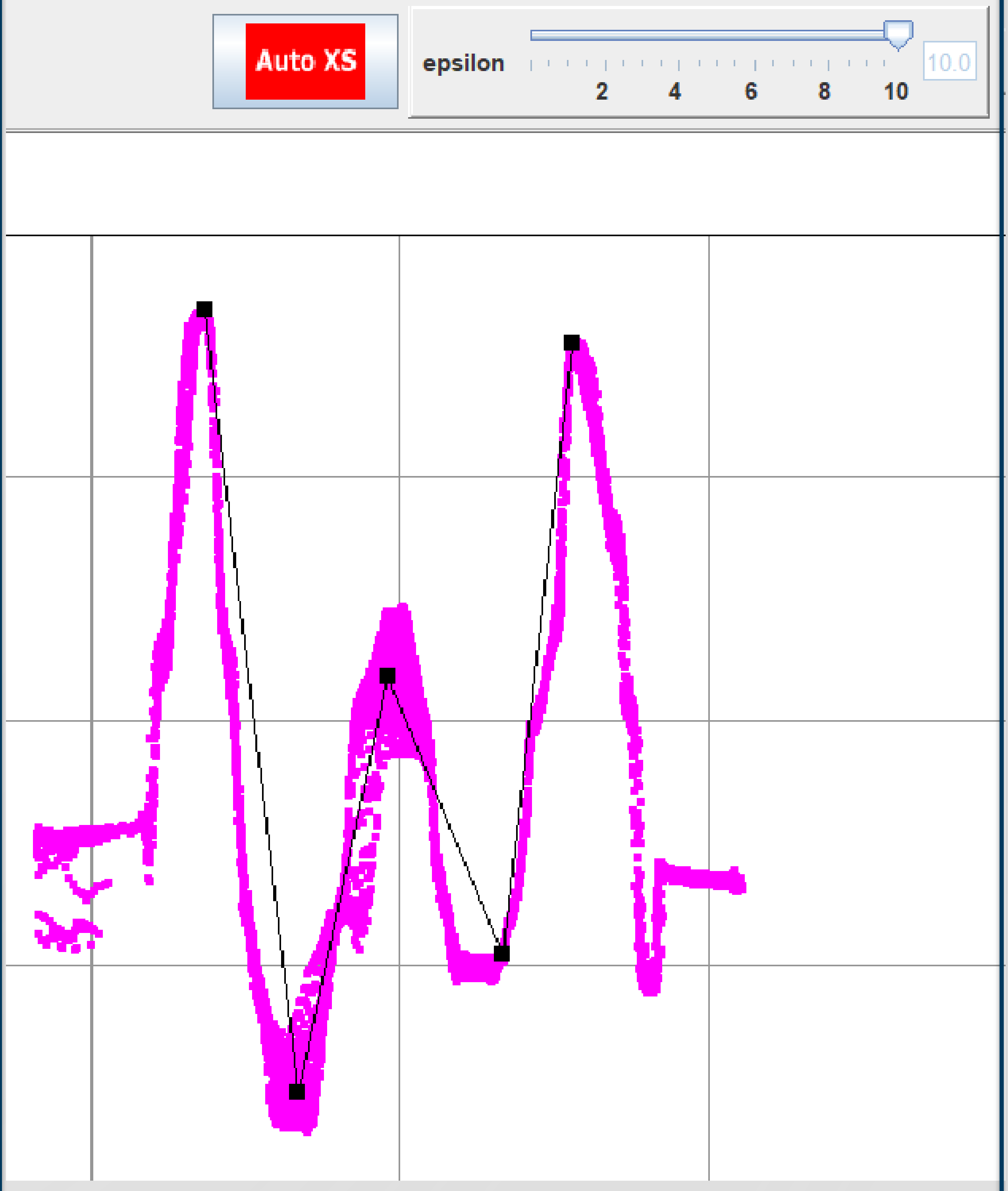
ε low: overfitting



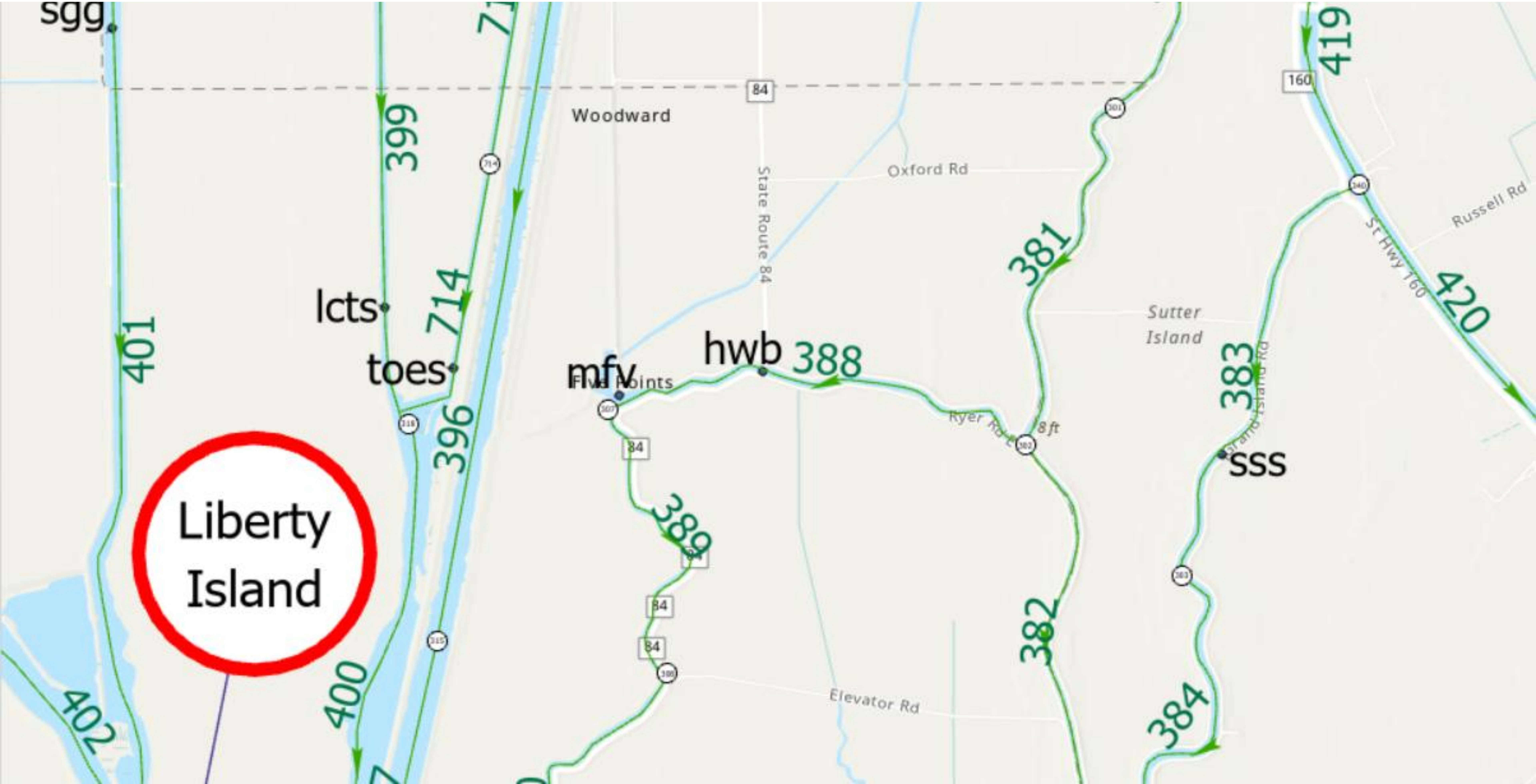
ε optimal



ε high: underfitting



Creating DSM2 output locations for monitoring stations

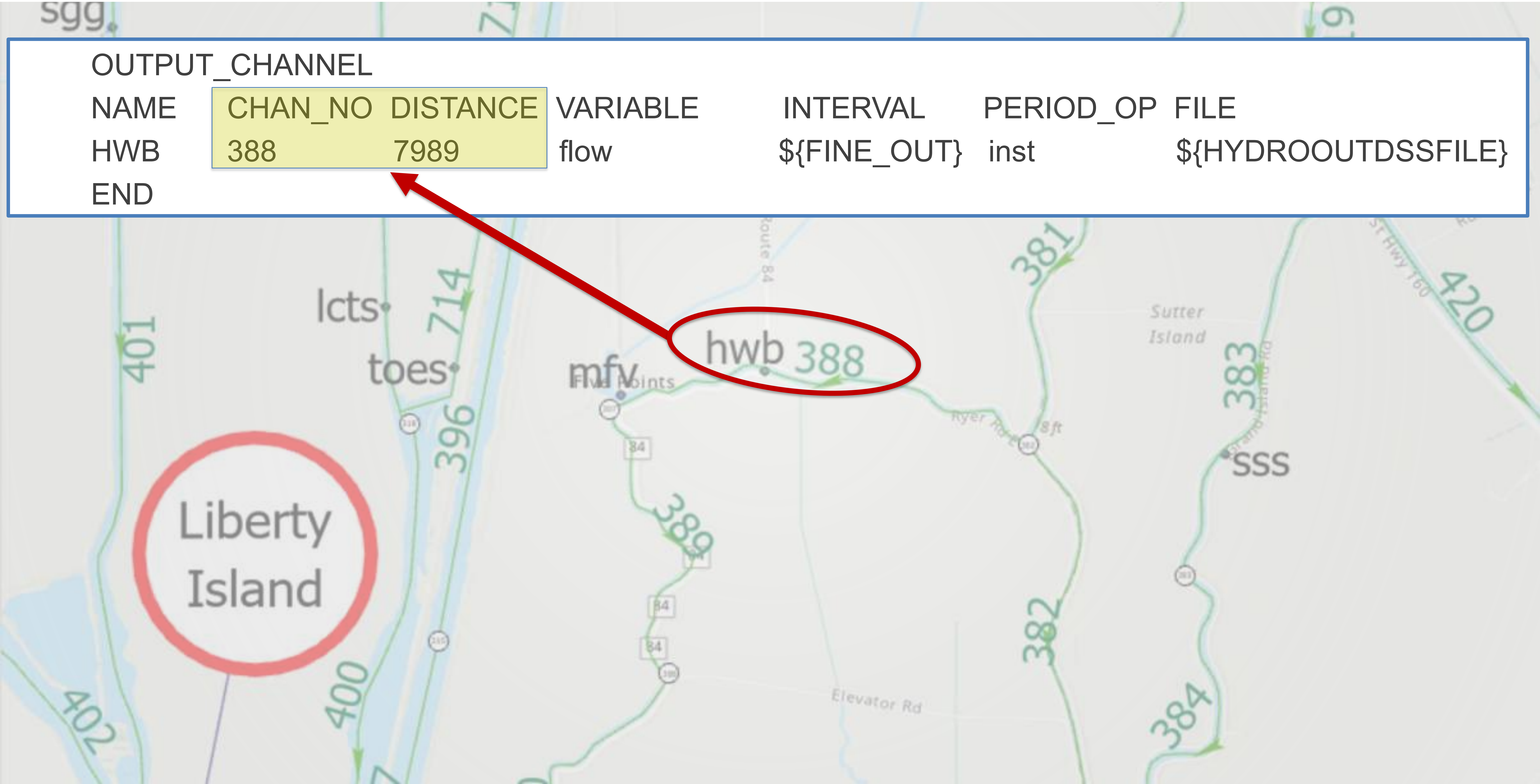


Creating DSM2 output locations for monitoring stations

OUTPUT_CHANNEL

NAME	CHAN_NO	DISTANCE	VARIABLE	INTERVAL	PERIOD_OP	FILE
HWB	388	7989	flow	${FINE_OUT}	inst	${HYDROOUTDSSFILE}

END



Creating DSM2 output locations for monitoring stations

CSDP data

- Channel Network
- Station coordinates
- DSM2 channel connectivity* (channels.inp)

→

CSDP

- Calculate Channel and distance for each station

→

DSM2

- output locations file** (output.inp)

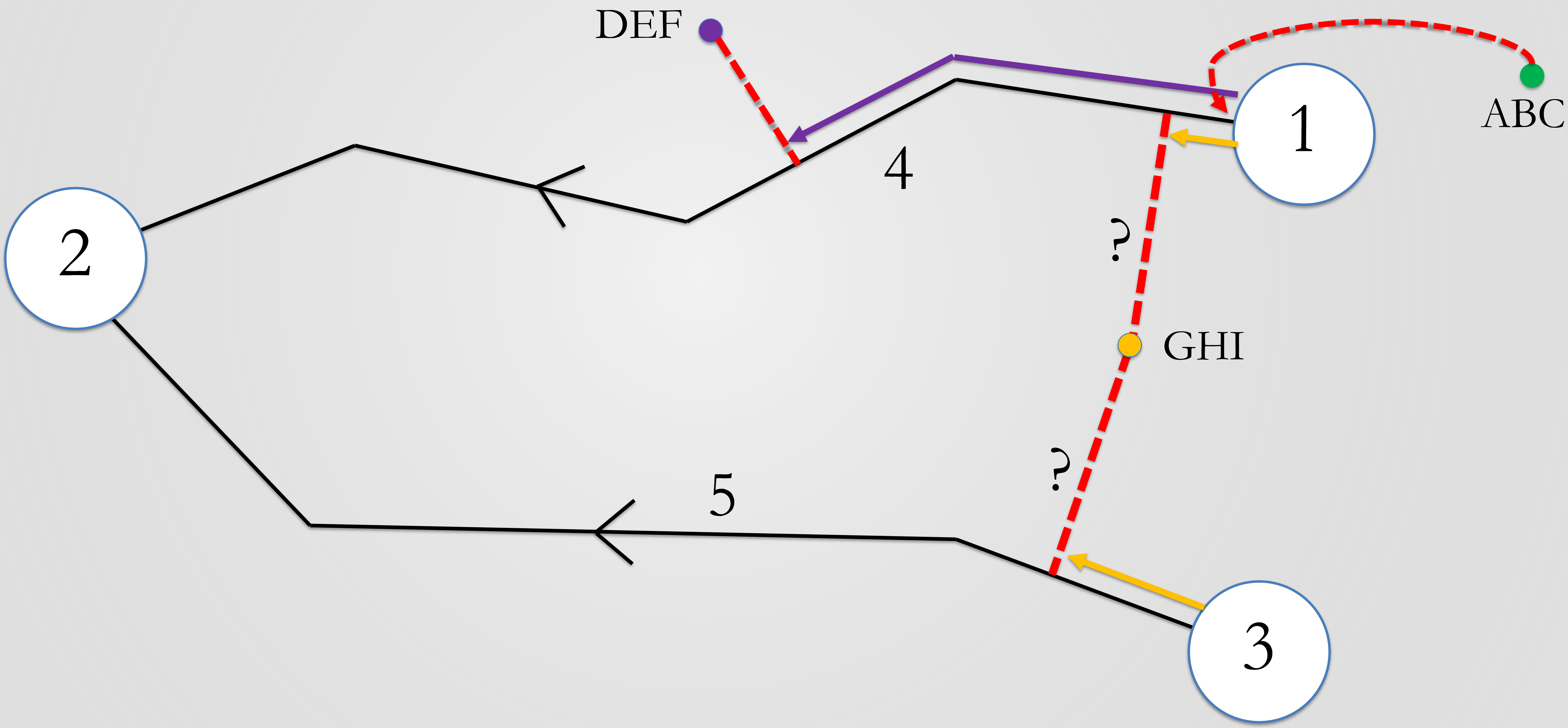
* Only required if channel lengths need to be scaled for compatibility with another grid, for which there are no CSDP data

** Output at some locations need to be adjusted manually, including

- San Andreas Landing (SAL), EC
- Holt, flow
- Middle River, flow

Creating DSM2 output locations for monitoring stations

Example: determining channel/distance for stations

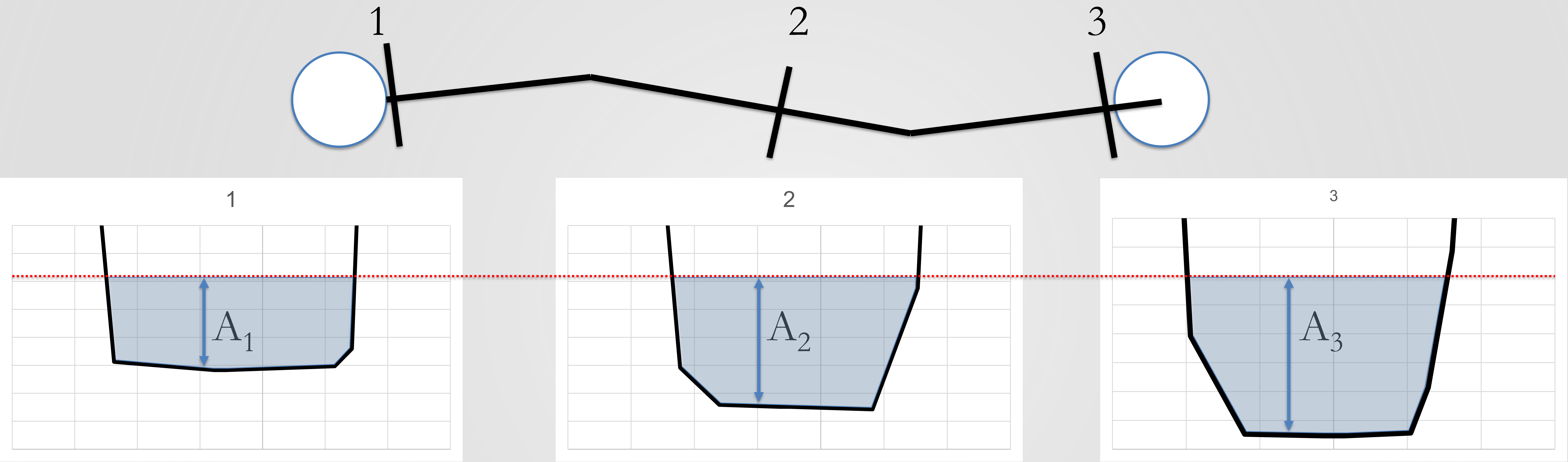


Cross-section adjustments to improve hydro convergence

- Network Maximum Adjacent Area Ratio (MAAR) Summary
- Channel 3D plot
- Channel Cross-section comparison graph
- Centerline Summary Window

Cross-section adjustments to improve hydro convergence

Maximum Area Ratio (MAR)



Max Adjacent Area Ratio

$$MAR = \frac{\max(A_1, A_1, \ldots A_n)}{\min(A_1, A_1, \ldots A_n)}$$

Where

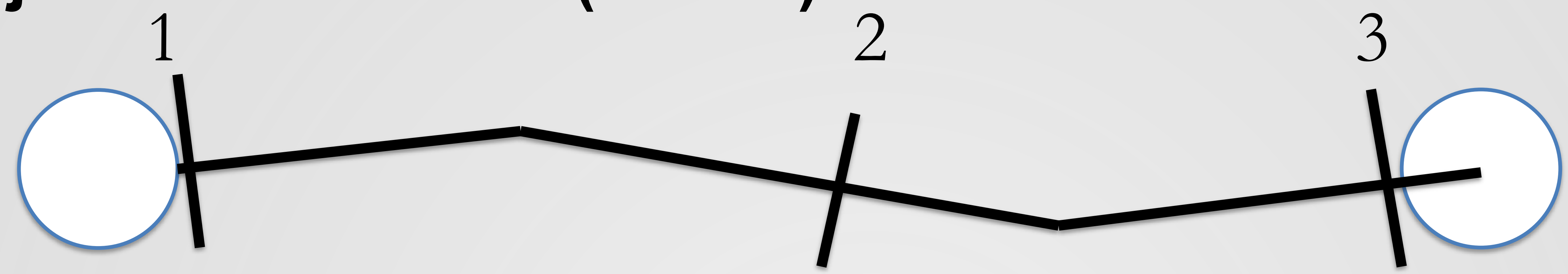
$1 \leq i \leq$ num cross-sections

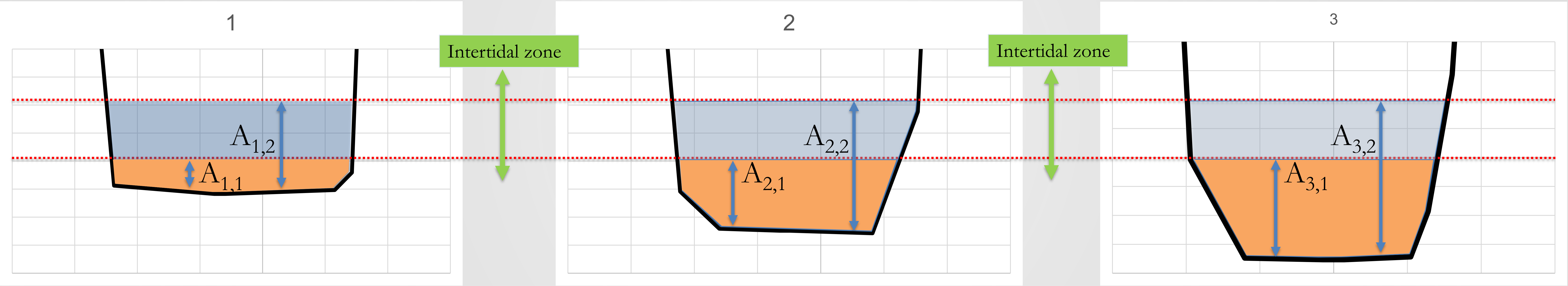
Sufficient condition to prevent "blowing up"

$$MAR < 2$$

Cross-section adjustments to improve hydro convergence

Maximum Adjacent Area Ratio (MAAR)





Adjacent Area Ratio

$$AAR_{i,j} = max\left[\frac{A_{i,j}}{A_{i+1,j}}, \frac{A_{i+1,j}}{A_{i,j}}\right]$$

Where

$1 \le i \le$ num cross-sections – 1

$1 \le j \le$ num elevation increments in intertidal zone

Max Adjacent Area Ratio

$$MAAR = max(AAR_{i,j})$$

Where

$1 \le i \le$ num cross-sections

$1 \le j \le$ num elevation increments in intertidal zone

Cross-section adjustments to improve hydro convergence

Network MAAR Summary

Channel	MAAR in IZ	elev	min mllw	max mhhw
184	6.33	3.5	3.59	6.15
801	4.97	6.0	3.76	6.39
406	3.81	2.5	2.05	6.34
482	3.69	1.5	1.10	6.77
195	3.38	4.0	3.93	6.56
493	3.33	2.5	2.06	6.34
255	3.31	5.5	2.39	6.10
204	2.84	6.0	3.49	6.14

Max MAAR in Intertidal zone

Elevation of Max MAAR in intertidal zone

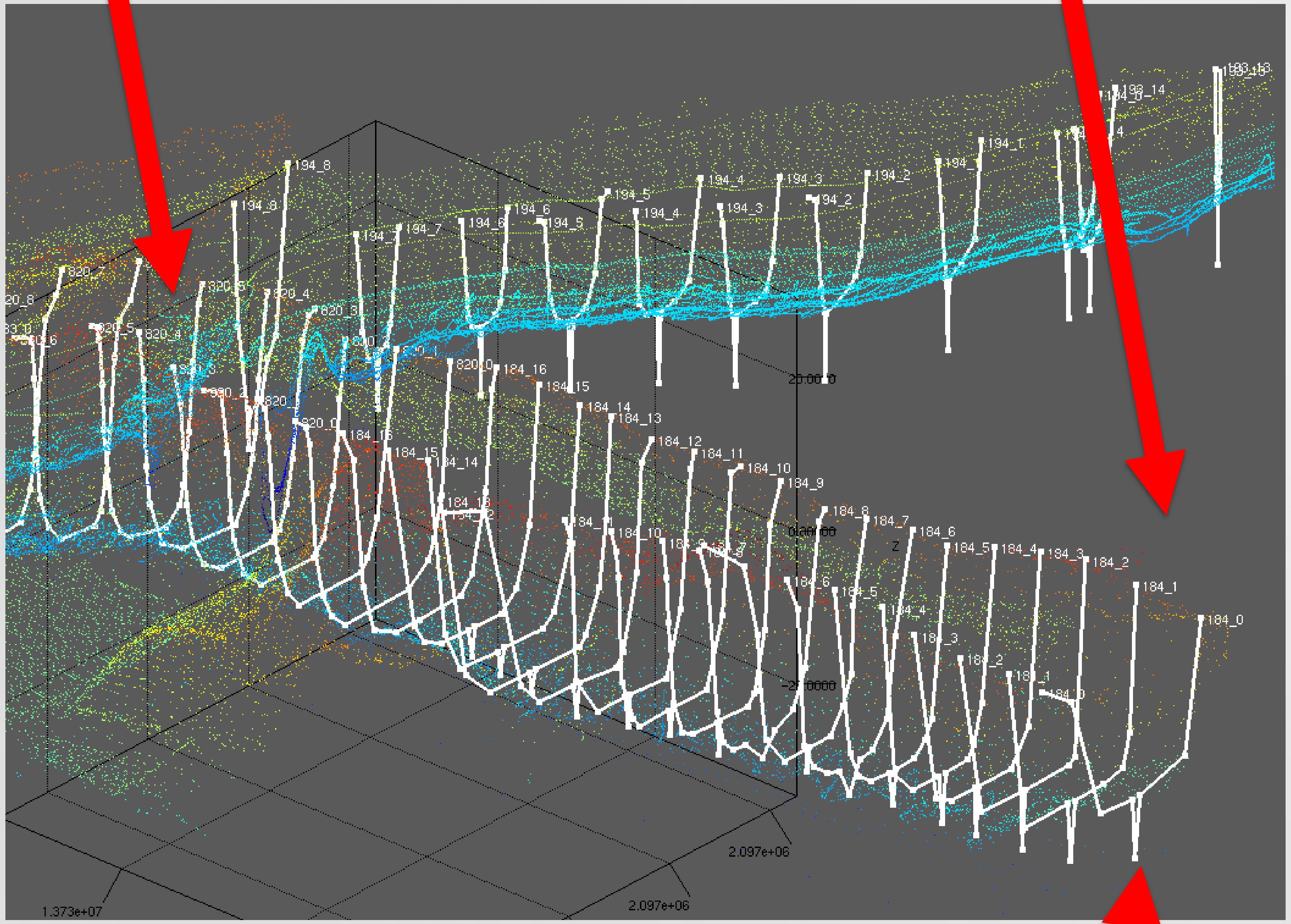
Cross-section adjustments to improve hydro convergence

Channel 3D plot

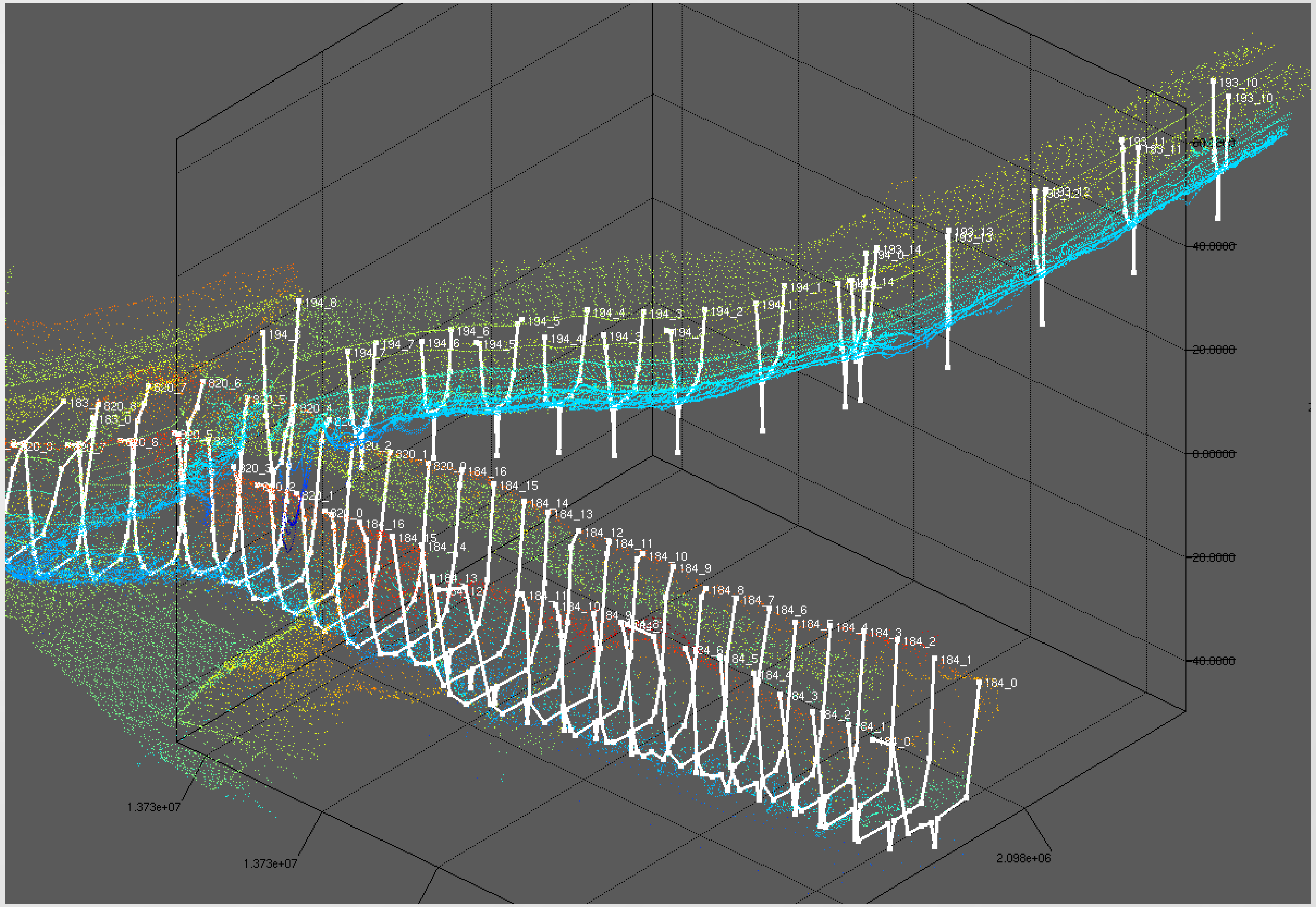
downstream end

upstream end

before adjustment



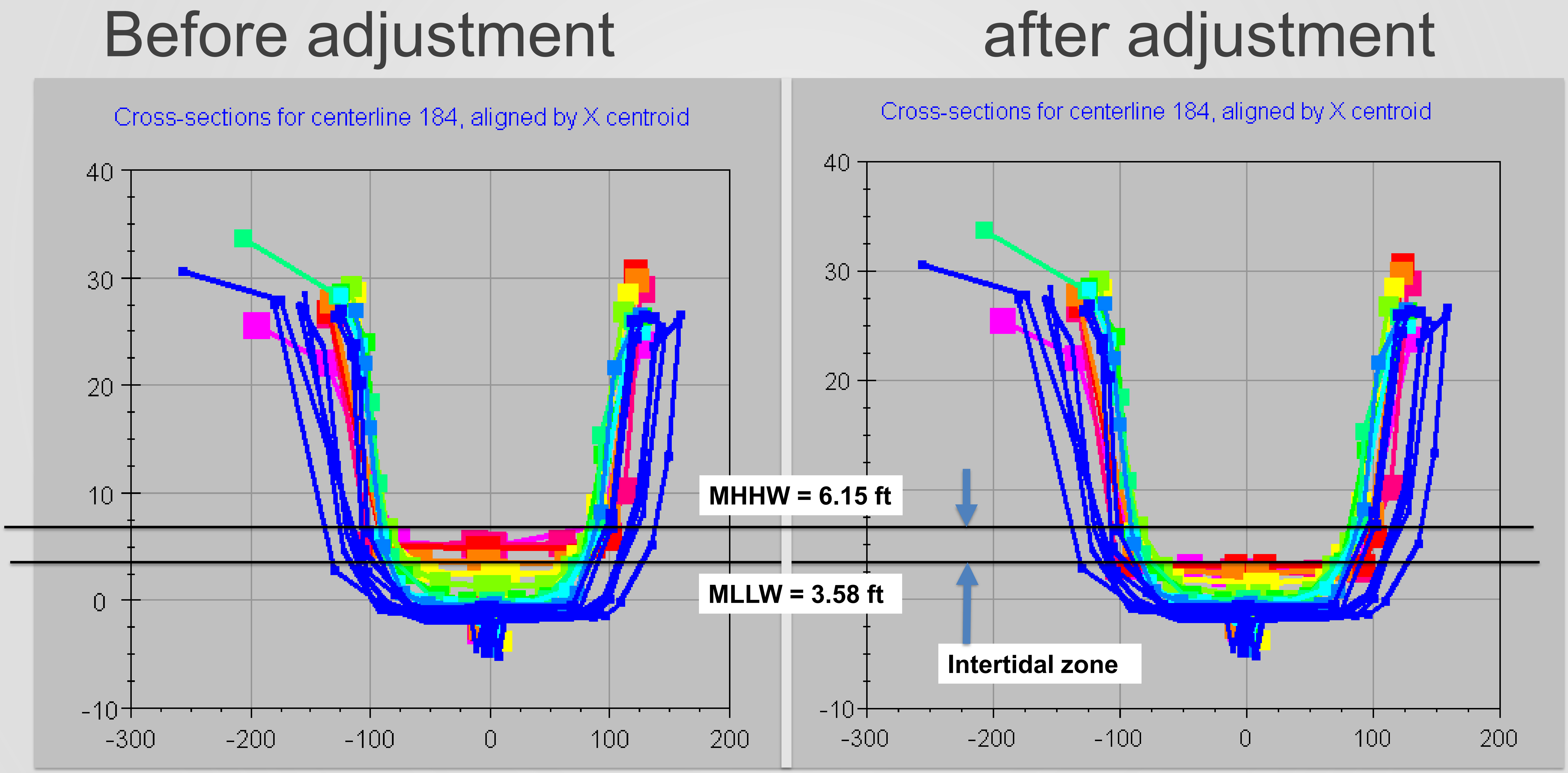
after adjustment



deep V shapes added to prevent drying up

Cross-section adjustments to improve hydro convergence

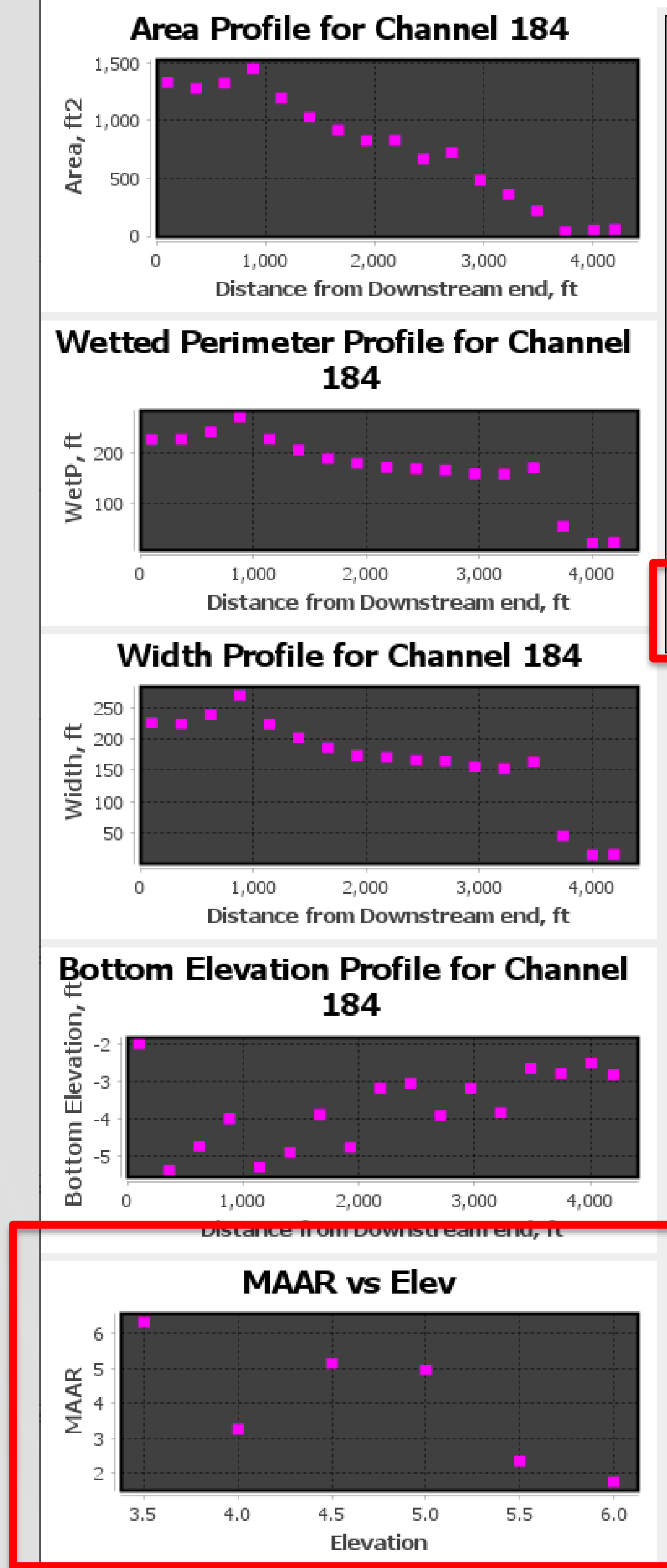
Channel cross-section comparison graph



Cross-section adjustments to improve hydro convergence

Centerline Summary Before changes

Summary for Channel 184



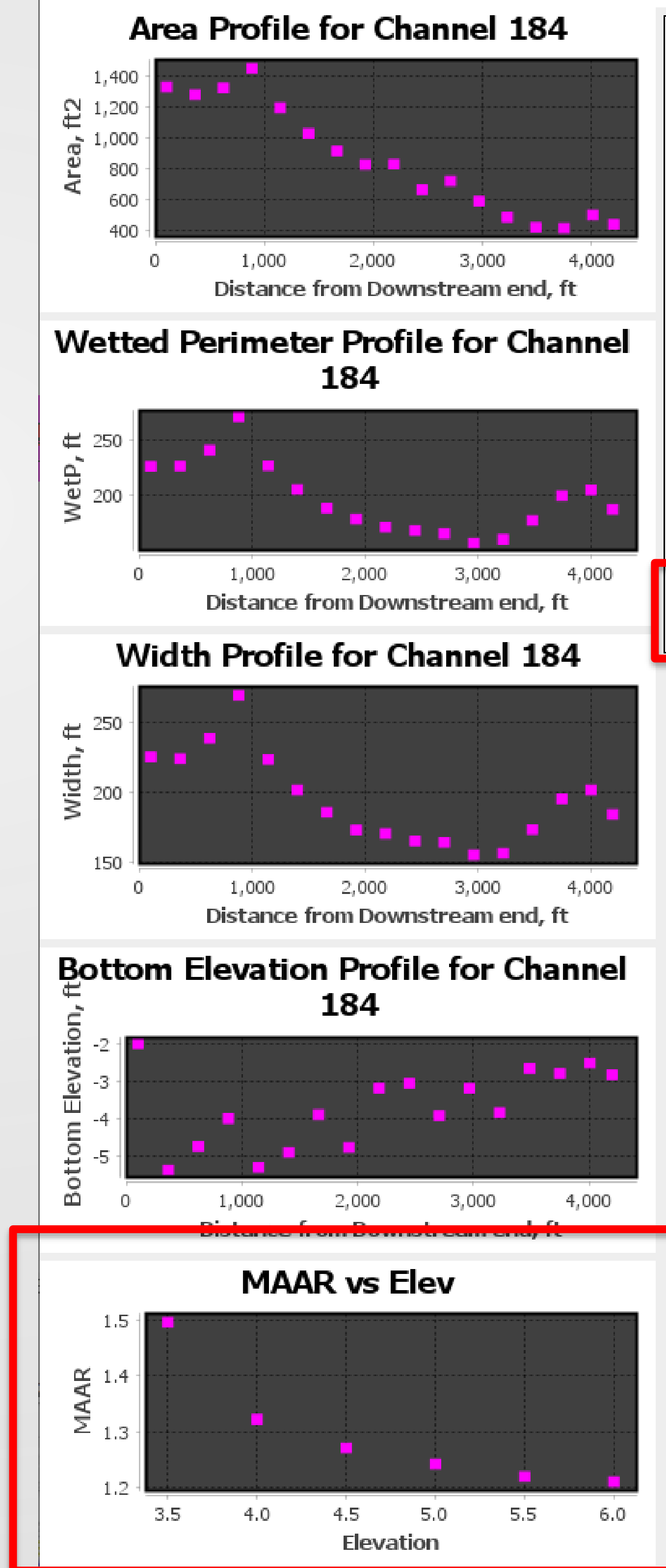
Centerline Summary

Volume, Wetted Area, and Surface area are estimates assuming no intepolation from adjacent channels, an elevation of 4.87 in the current datum, and linear variation between cross-sections.
Intertidal Zone: 3.5<=Z<=6.5

Maximum Adjacent Area Ratio (MAAR) is, for each 0.5 foot elevation increment in the intertidal zone, the maximum ratio of cross-sectional areas between adjacent cross-sections.

Elevation, ft	4.87
Centerline Length, ft	4,265.7
Channel Volume, ft3	3,276,055.5
Channel Wetted Area, ft2	734,623.0
Channel Surface Area, ft2	716,753.9
Channel Max Area Ratio	41.5
Channel Max Adjacent Area Ratio Elevation	3.5
Channel Max Adjacent Area Ratio	6.3

Summary for Channel 184



Centerline Summary

Volume, Wetted Area, and Surface area are estimates assuming no intepolation from adjacent channels, an elevation of 4.87 in the current datum, and linear variation between cross-sections.
Intertidal Zone: 3.5<=Z<=6.5

Maximum Adjacent Area Ratio (MAAR) is, for each 0.5 foot elevation increment in the intertidal zone, the maximum ratio of cross-sectional areas between adjacent cross-sections.

Elevation, ft	4.87
Centerline Length, ft	4,265.7
Channel Volume, ft3	3,652,077.0
Channel Wetted Area, ft2	843,928.4
Channel Surface Area, ft2	829,421.2
Channel Max Area Ratio	3.5
Channel Max Adjacent Area Ratio Elevation	3.5
Channel Max Adjacent Area Ratio	1.5

Results

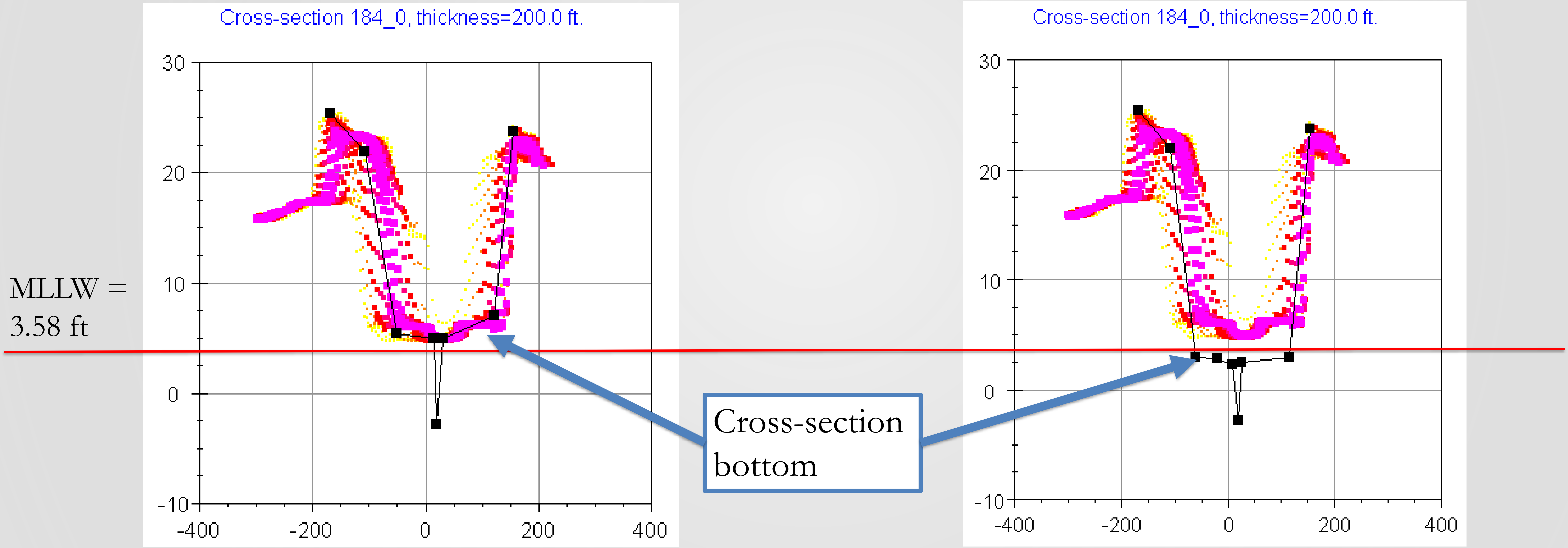
- Total iterations for hydro run decreased by 0.9%
- MAAR decreased from 6.3 to 1.5

Adjusting cross-sections to improve hydro convergence

Lowering cross-section bottom below MLLW

Before: bottom above MLLW

After: bottom below MLLW



Adjusting cross-sections to improve hydro convergence

Results of adjustments

- Reduced MAAR in the channel from 6.3 to 1.3
- Reduced iterations in the DSM2 hydro simulation by 0.9%

Conclusions

1. The CSDP can create shapefiles for GIS grid maps
2. Automatic cross-section creation works in areas with more recent survey data
3. The CSDP can create DSM2 output locations automatically for all but a few stations.
4. MAAR is a useful metric for improving convergence.

Acknowledgements

Nicky Sandhu
Zhenlin Zhang

Questions?

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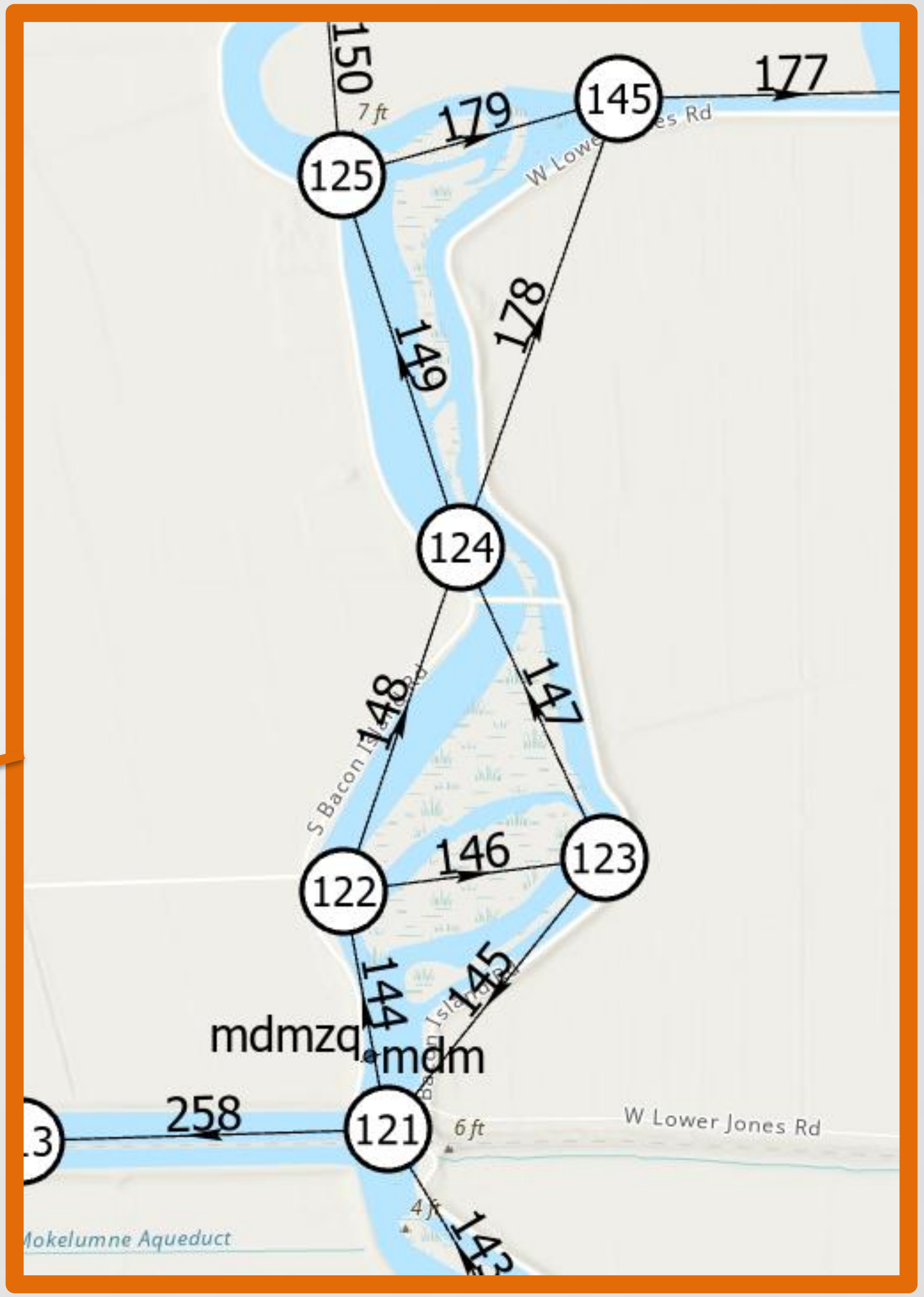
Extra Slides

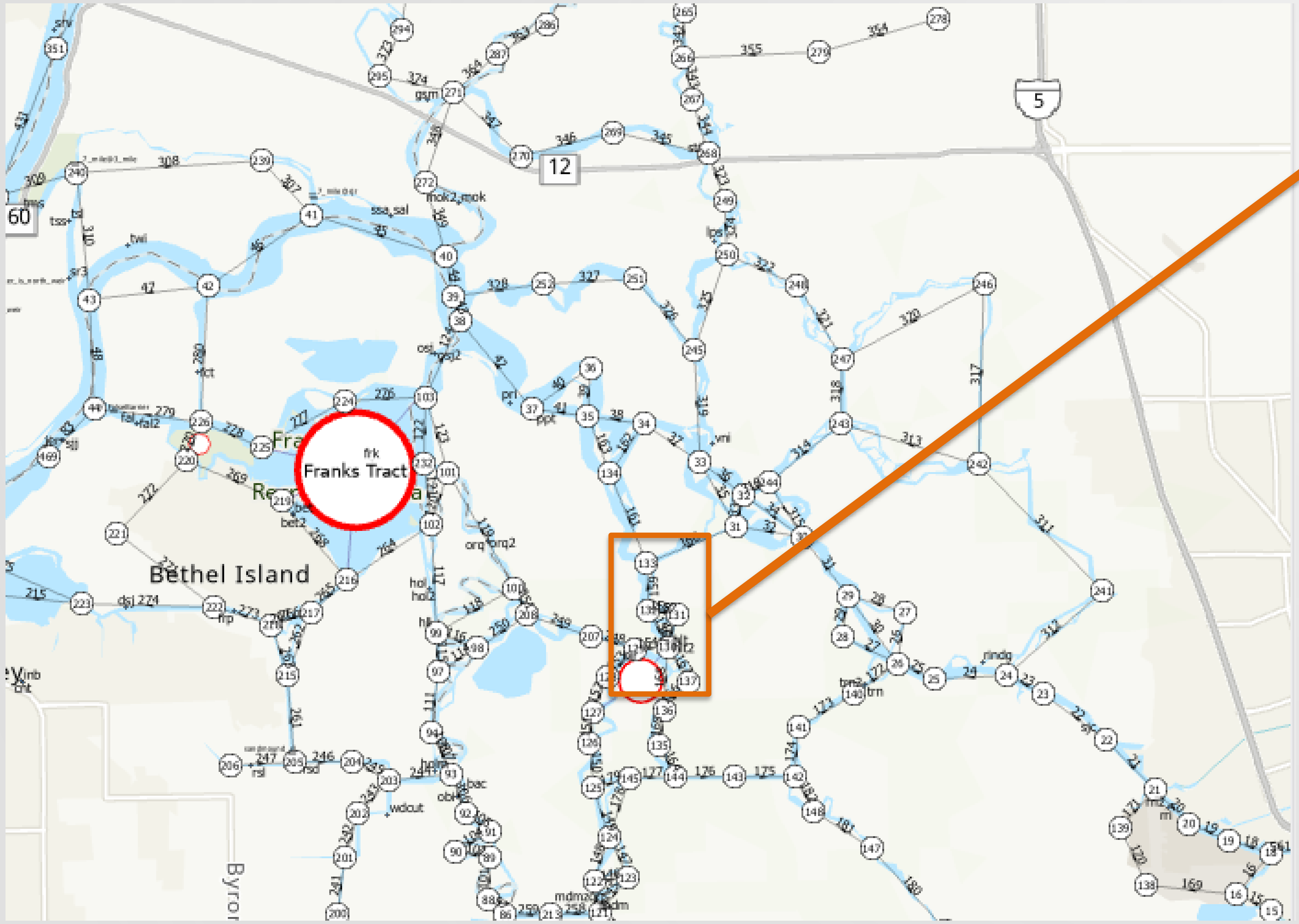
Output locations needing manual adjustment

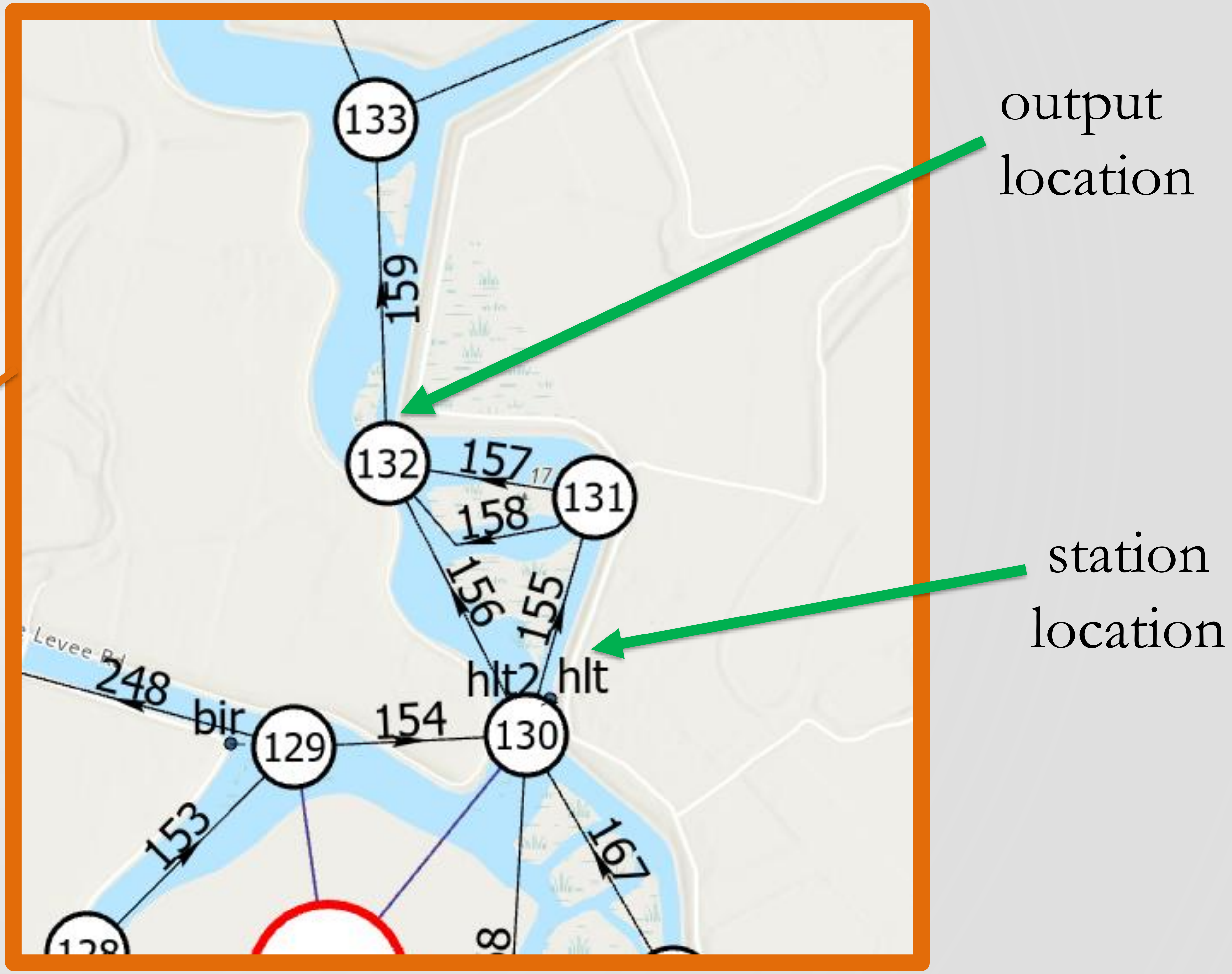
Middle River at Middle River (MDM)



Creating DSM2 output locations

Output locations needing manual adjustment:
Holt(HLT)

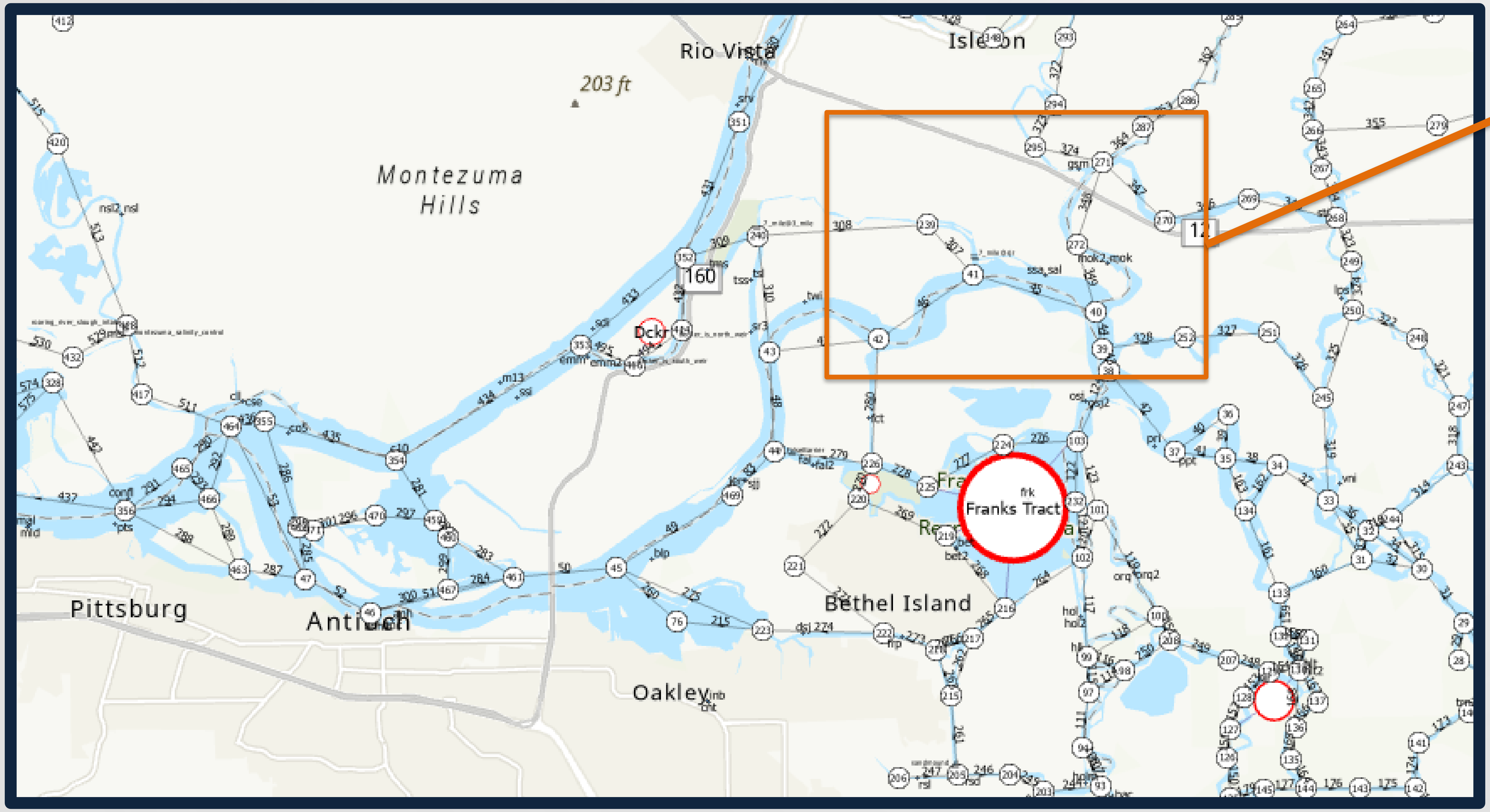


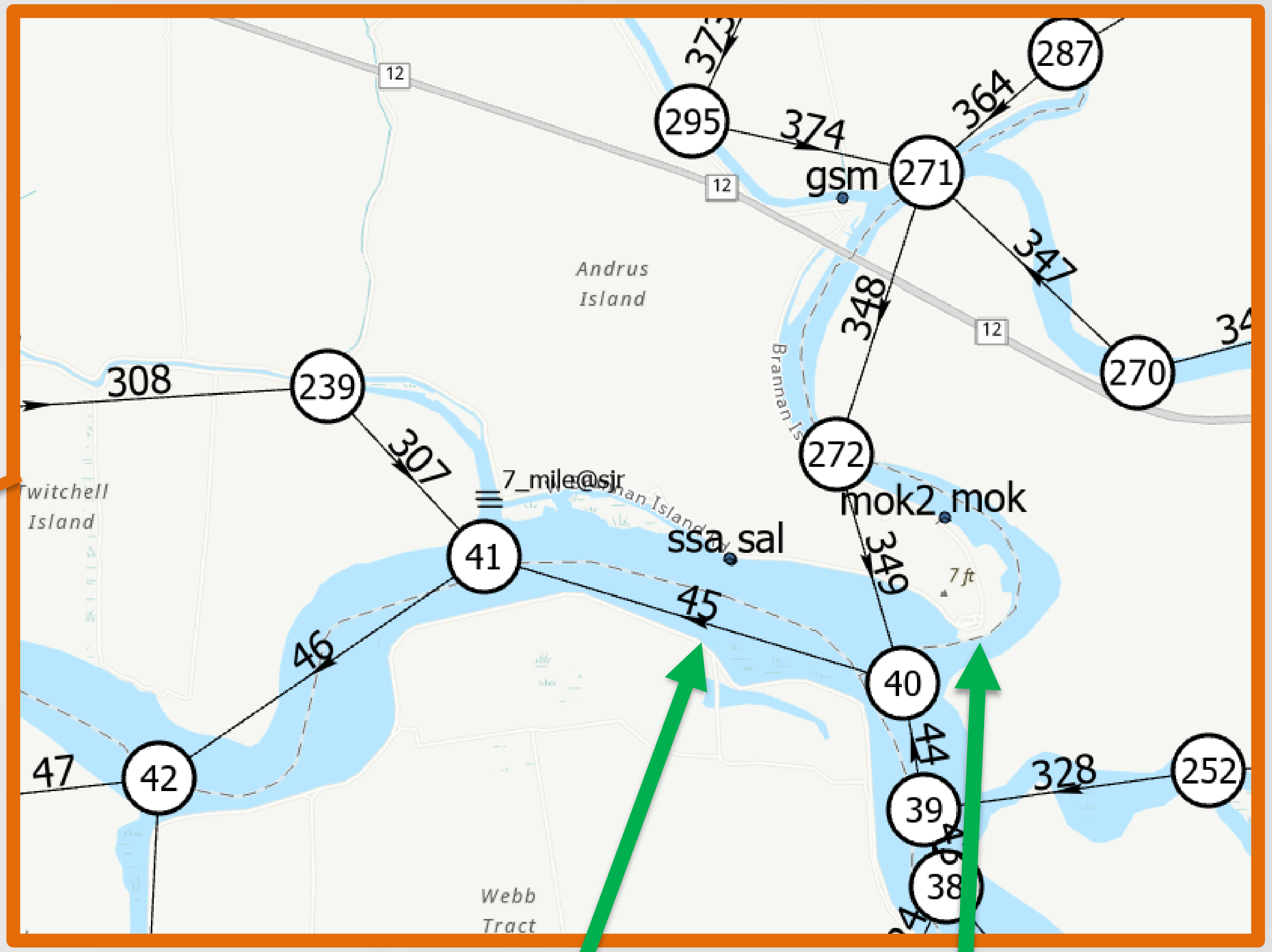


Creating DSM2 output locations

Output locations needing manual adjustment:

EC at San Andreas Landing (SAL)



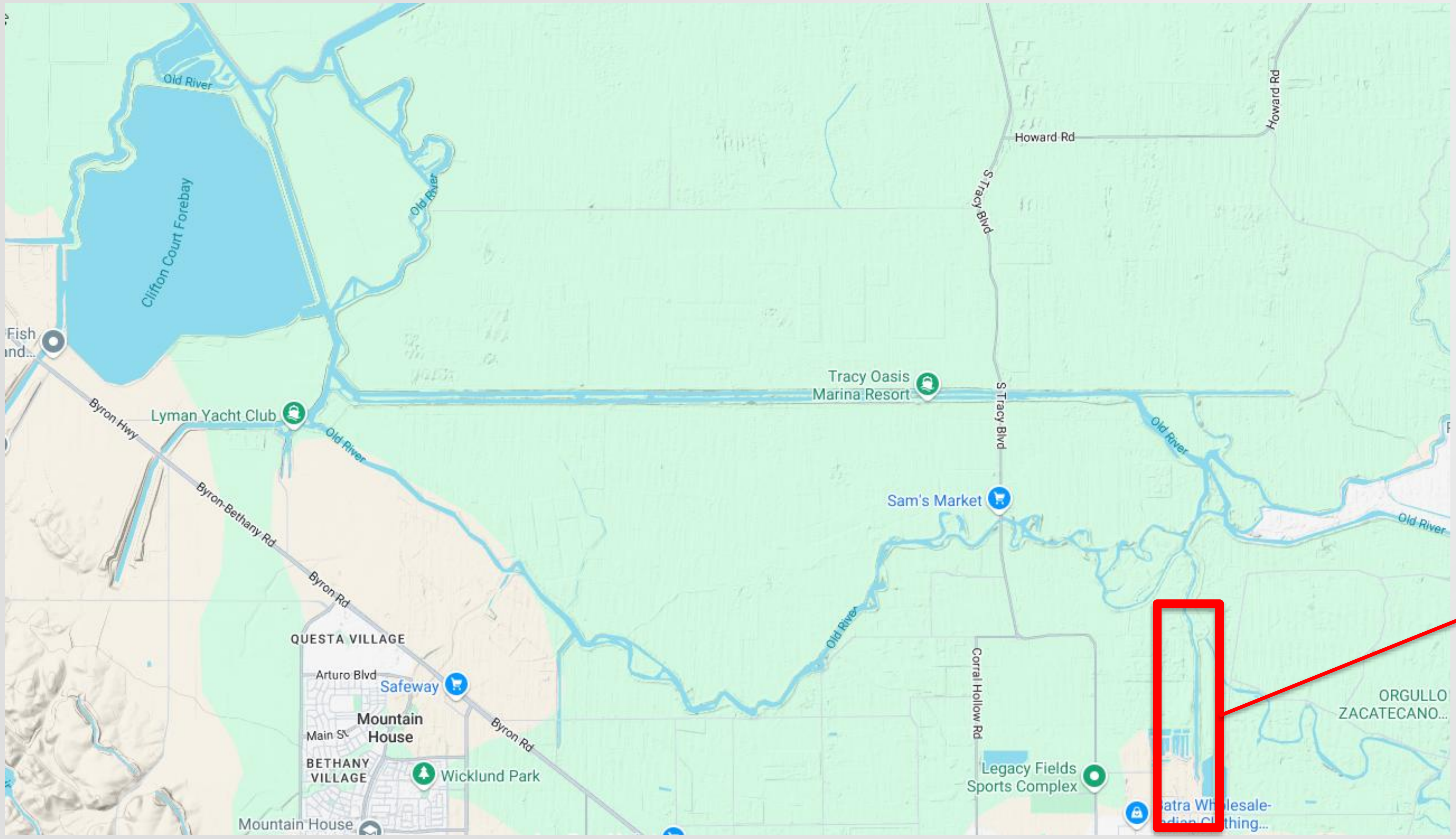


station location

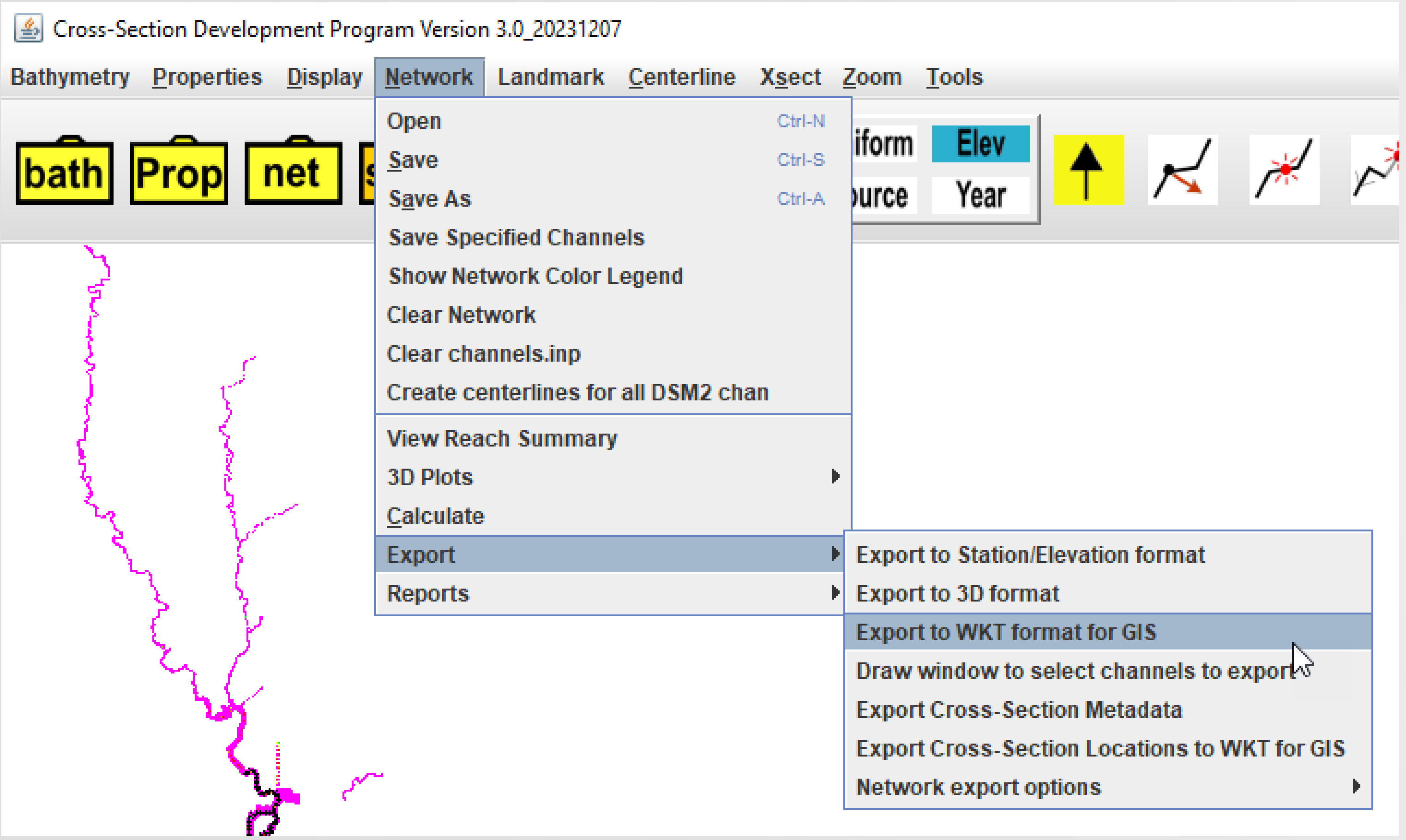
output location

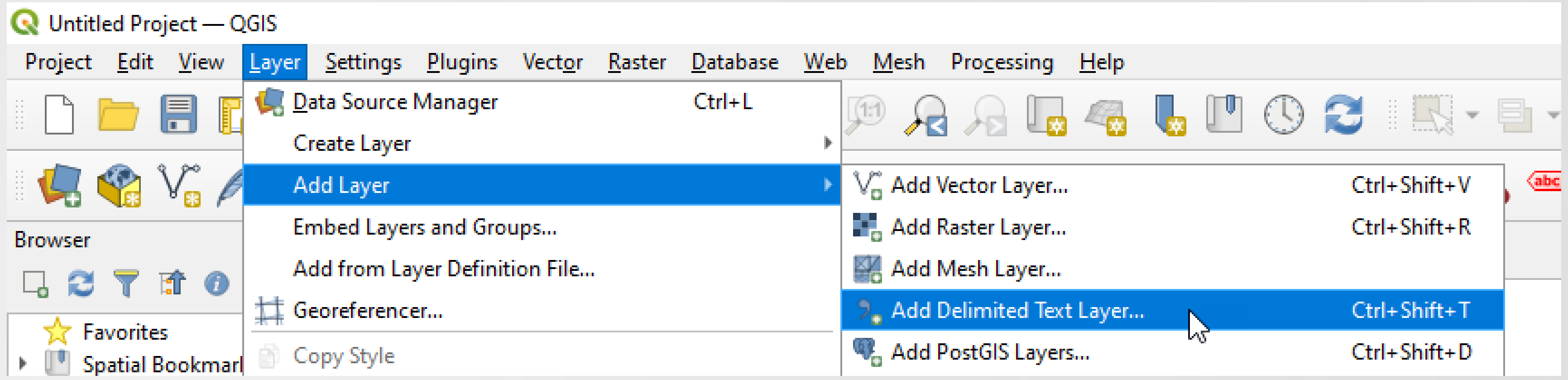
Cross-section adjustments to improve hydro convergence

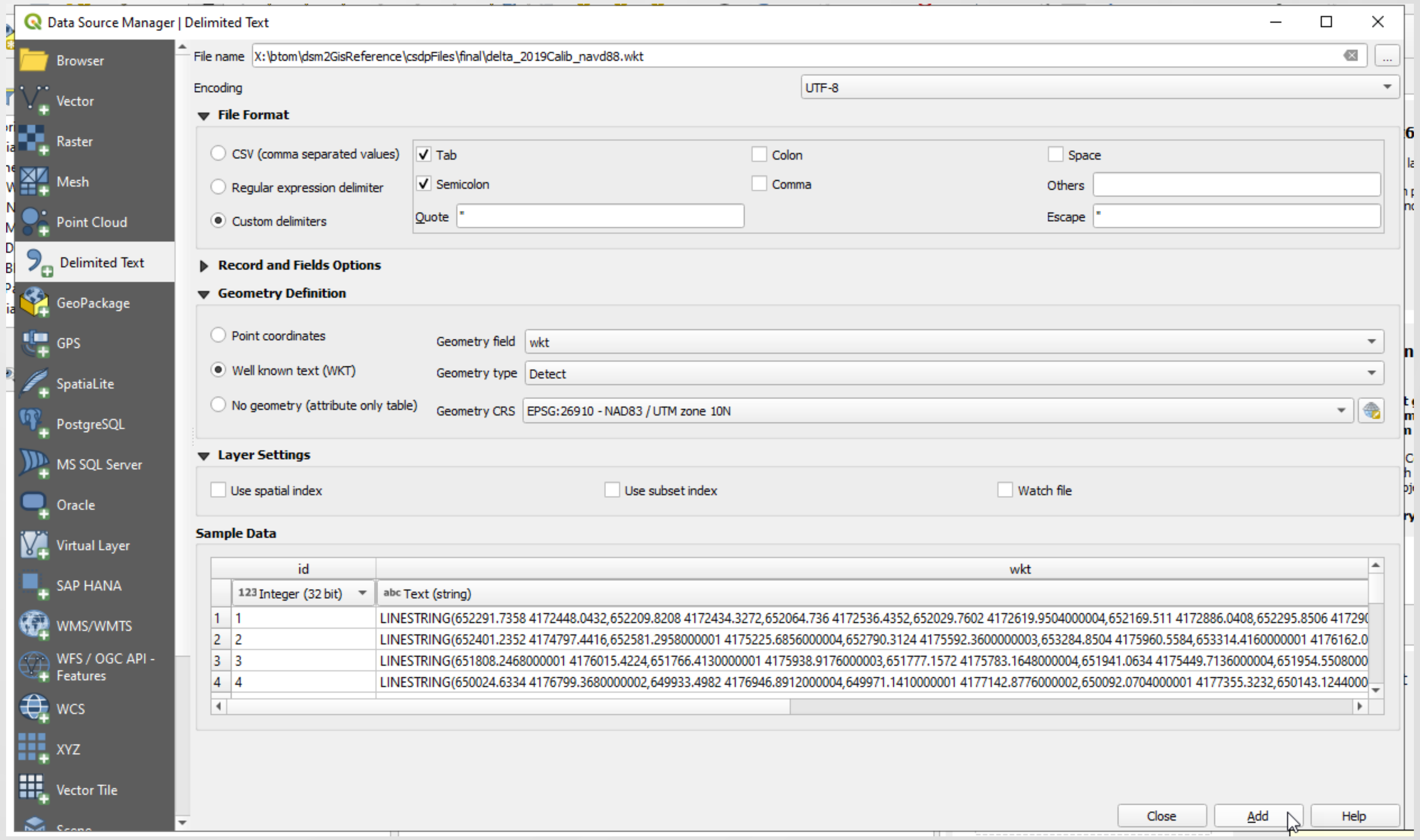
Channel 184: Sugar Cut



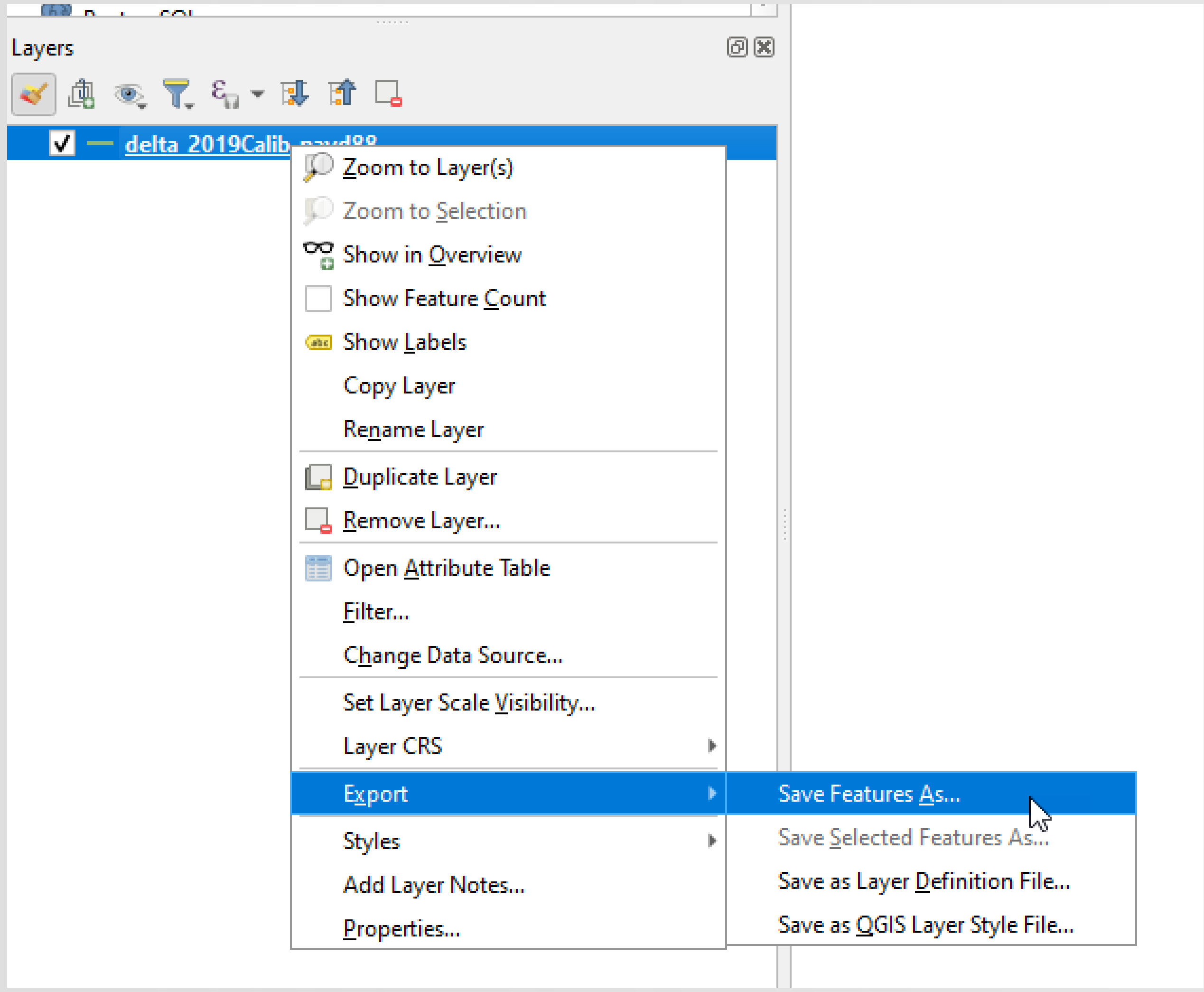
Creating GIS shapefiles from CSDP data

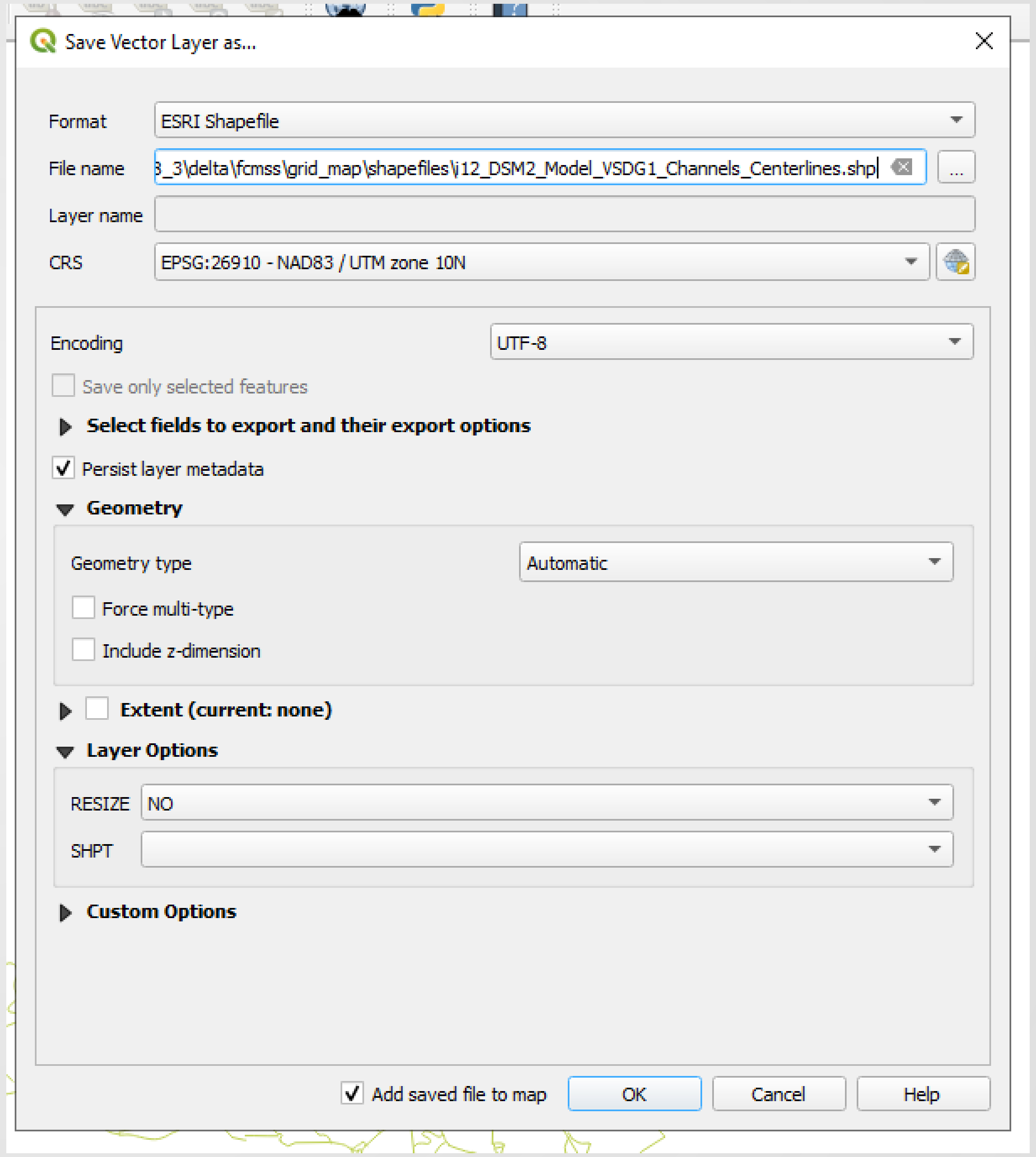






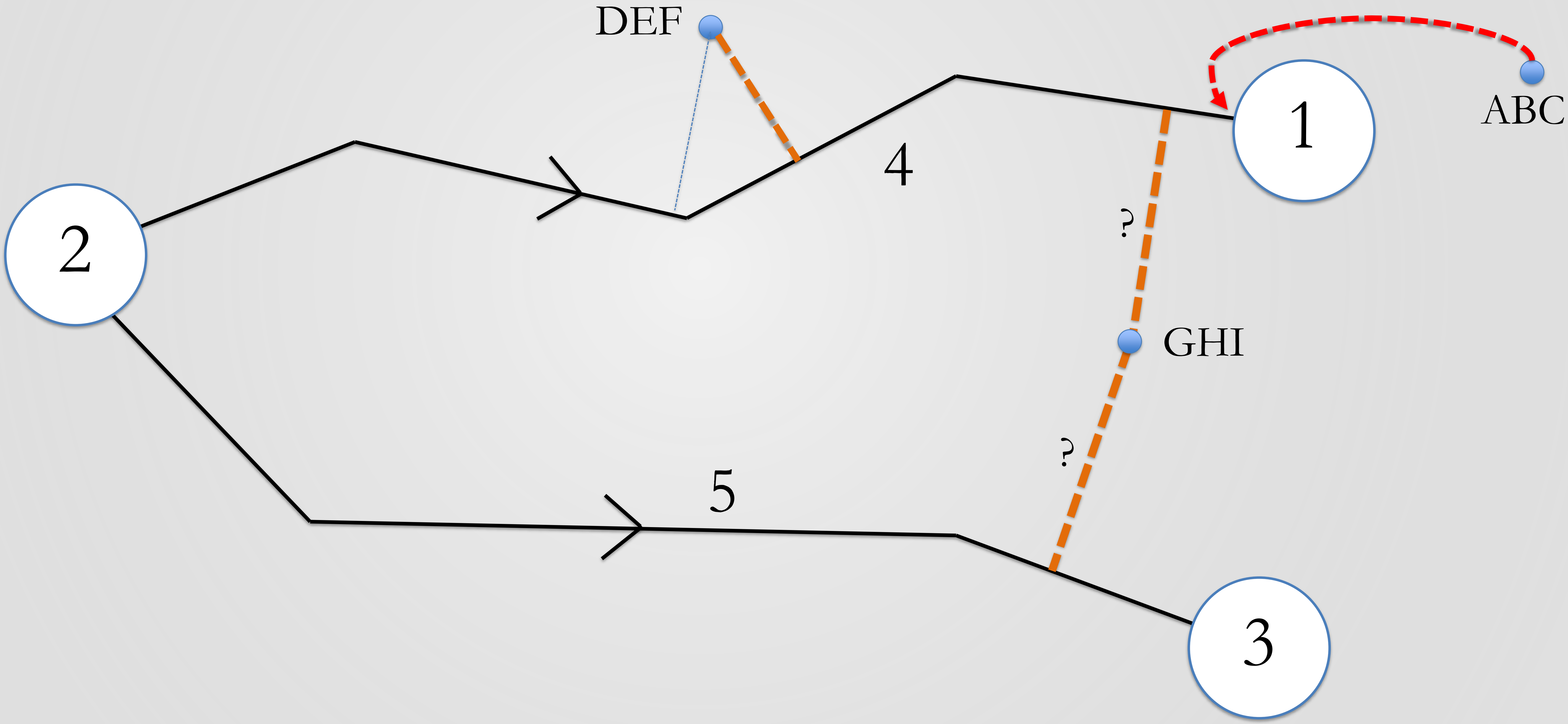
Creating GIS shapefiles from CSDP data





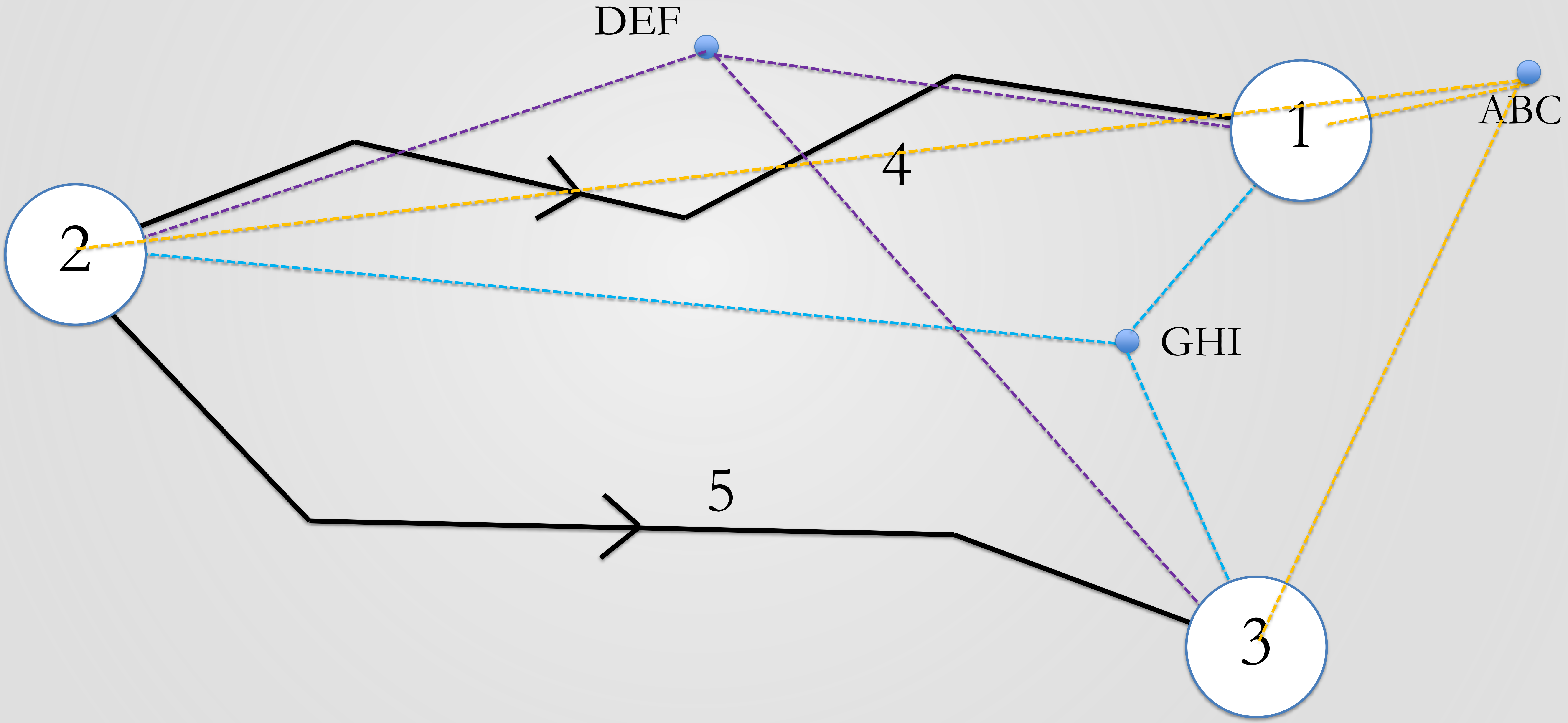
Creating DSM2 output locations

Step 3: Choose min(closest ⊥ dist, closest channel end)



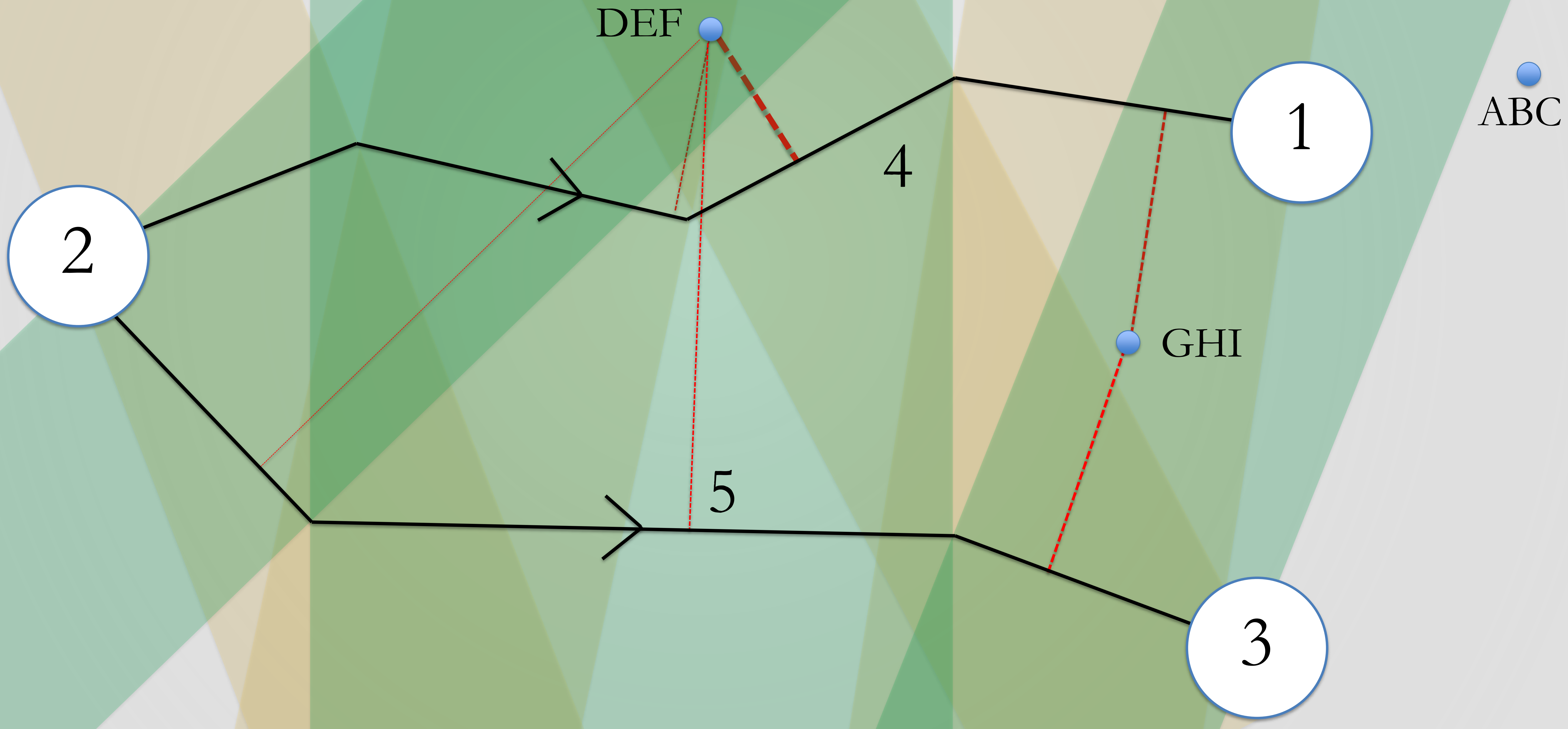
Creating DSM2 output locations

Step 1: Calculate distance to channel ends & find minimum distance



Creating DSM2 output locations

Step 2: Calculate ⊥ distance from station to every line segment



Creating DSM2 output locations

If no matching CSDP network file: scale distances

- Assume channels are in roughly the same location
- distances are scaled using ratio of channel lengths

$$dist_{old\_grid} = \frac{channel\_length_{old\_grid}}{channel\_length_{new\_grid}} \times dist_{new\_grid}$$